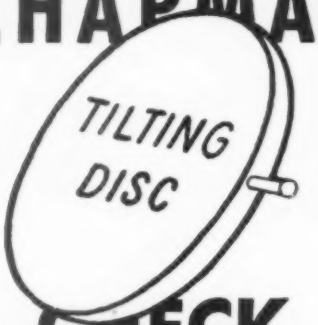
WATER & SEWAGE WORKS

"SLUDGE BY THE GALLON" AT MARION, INDIANA

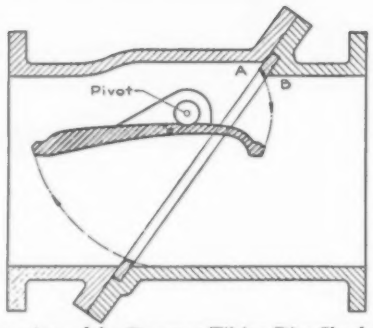
Floating Disc Action Gives

CHAPMAN



CHECK VALVES

Quick, Quiet Closing



Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

Unlike ordinary check valves, Chapman Tilting Disc Check Valves have a balanced hinged-pin disc *which works with the stream.* The disc closes quickly and quietly, with its motion cushioned by the effect of the stream against the short flap. Since there is no slamming of the disc, hammering and pipe line stresses are eliminated.

Not only does this unique valve minimize maintenance costs but it also reduces head losses 65% to 85% over conventional type check valves. When installed on pump discharge lines substantial power savings are possible.

For engineering data and test results send for bulletin.

THE **CHAPMAN** VALVE
MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS

WATER AND SEWAGE WORKS. Reg. U. S. Patent Off. October, 1948. Volume 95. Number 10. Published monthly by Gillette Publishing Co. at 404 North Wesley Ave., Mount Morris, Ill. Per copy, 25c; except *this issue*, 75 cents. Subscription rate: United States, $2.00 per year; Canada, $2.00 per year; Foreign, $3.00 per year. Entered as second-class matter March 4, 1948, at the post office at Mount Morris, Illinois, under the Act of March 3, 1879. Executive and business offices, 22 W. Maple St., Chicago 10, Illinois. Editorial office, 155 E. 44th St., New York 17, N. Y.

64 YEARS

OF SUCCESSFUL PERFORMANCE

TYPE 12
FROST PROOF MODEL

TYPE 14
FOR WARM CLIMATES

behind the EMPIRE NAME

EXCLUSIVE

There is no substitute for experience. For over 64 years water meter users have experienced complete measurement satisfaction from the Empire design. Precision and durability are the *plus* values that meter buyers have learned to expect. And remember, today's Empire meters are even better constructed than those made in the past. Investigate metering the Empire way. You'll get *lasting accuracy* for the *longest life* at the *lowest cost*. Write for bulletins.

PITTSBURGH EQUITABLE METER DIVISION
ROCKWELL MANUFACTURING COMPANY
Pittsburgh 8, Pa.

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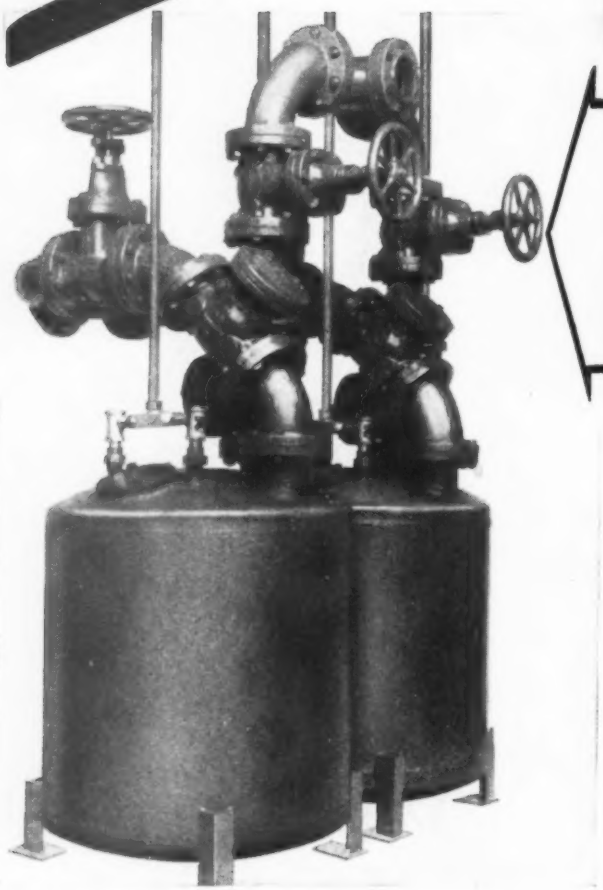
New York Pittsburgh San Francisco Seattle Tulsa

ROCKWELL

Empire OSCILLATING PISTON Meters

NEW CARTER Pneumatic SEWAGE EJECTOR



The ideal solution for those troublesome small capacity sewage pumping problems!

If you have been faced with the necessity and expense of installing mechanical shredders or screws before your "non-clog" sewage pumps and the subsequent maintenance problems involved, the CARTER pneumatic ejector unit is your answer.

In the CARTER unit sewage entering the hermetically sealed pot may contain solids up to 4" spheres. These are efficiently handled without clogging because the CARTER pneumatic ejector, which is electrode controlled, contains no moving parts.

In addition to their hydraulic ability, probably the most important additional feature is the guarantee of a strictly sanitary gas free installation that these units provide.

Wet wells for either submerged type centrifugal or dry pit sewage pumps usually contain an accumulation of sludge. This becomes septic and generates highly explosive methane or marsh and hydrogen sulphide gases.

In the CARTER ejector there can be no accumulation of solids because the entire contents of the hermetically sealed pot is expelled every time the electrode circuit is closed. There is no septic action or gas production therefore, nor can gas enter the sewer system because of the trapped inlet.

CARTER

OVER 50 YEARS OF SERVICE

• *Write for further information*

★ OTHER EQUIPMENT •

MIXING • FLOCCULATION • DIGESTERS •
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DIAPHRAGM PUMPS • PNEUMATIC EJECTORS

RALPH B. CARTER COMPANY
HACKENSACK, NEW JERSEY

WATER & SEWAGE WORKS

WATER SUPPLY—SEWAGE DISPOSAL—INDUSTRIAL WASTE TREATMENT

E. S. GILLETTE, Publisher

L. H. ENSLOW, Editor

COMING

Late Development in Prestressed Concrete Pipe

When cast-iron pipe manufacturers go into the production of prestressed concrete pipe for high pressure service, it is NEWS. Well, this is what is taking place, as is told in a revealing story of how this economical, light-weight pipe is being produced for the Cuban Government in a joint undertaking by the U.S. Pipe and Foundry Co. and Pont-A-Mousson of France. The pipe being produced, in 22 ft. lengths, in diameters of 24, 30 and 36 inches for 150 psi. service, is thin walled reinforced pipe which is given strength and high-density by prestressing. The basic principles and economy of design, method of manufacture, and testing, are described and evaluated by a specialist of many years' experience in concrete pipe production and applications—

M. W. LOVING, Consulting Engr.,
Glenview, Ill.

Preconditioning and Digestion of Sewage Sludge

Is to be discussed in a series of articles by a well qualified author with considerable plant operating experience. These articles are based on lectures by the author before the Short School for Sewage Works Operators at Penna. State College. Although written especially for the benefit of plant operators, these articles are not without value as a guide to plant designers. The contributor, already known to our older readers, is—

T. R. HASELTINE, Partner,
The Chester Engrs., Pittsburgh, Pa.

Reconditioning a 24 in. Cast Iron Water Main

Is the story of a tuberculated raw-water main at Charlotte, N.C., whose "C" value had dropped to 69, and how, by cleaning and lining in place, the "C" value of 130 was restored. This article is of particular interest because of the method of taking bids for the restoration work, by the application of a cement lining and a bituminous lining in place, and a detailed description of the Pittsburgh-Eric Process of bituminous lining electrolytically, as employed by the successful bidder on a guaranteed basis. The contributor, who served as consulting engineer on the project, is—

GEORGE S. RAWLINS,
J. N. Pease, Engrs., Charlotte, N.C.

Chemistry of Water Treatment

Is of particular interest to water purification engineers and chemists, but this series of papers on coagulation and water softening will be read with profit by any person in the field of water supply. These fundamental articles have been prepared from lectures given before a short school by—

DR. A. P. BLACK,
Prof. of Chemistry, Univ. of Florida.

The Pollution Assimilating Capacity of Streams

In these times of attempting to evaluate the pollution loading which a given stream may be expected to assimilate without creating a public nuisance, or hazard to public health, the author of this paper has developed a mathematically exact method of arriving at the safe pollution load for the more commonly met combinations of stream conditions. The end sought is the fullest permissible utilization of "self purification" of streams in determining the degree of waste and sewage treatment required. The author is—

HAROLD A. THOMAS, JR.,
Assoc. Prof. of Sanitary Eng., Harvard Univ.

Water for Industry

May often be taken for granted, but the quality and quantity of that water may be of far greater importance than water used for normal domestic supplies. Such is the implication of this review of the problem by—

GEORGE W. REID, Assoc. Prof.,
Ga. Inst. of Technology

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(Member—Audit Bureau of Circulation and Associated Business Papers.)

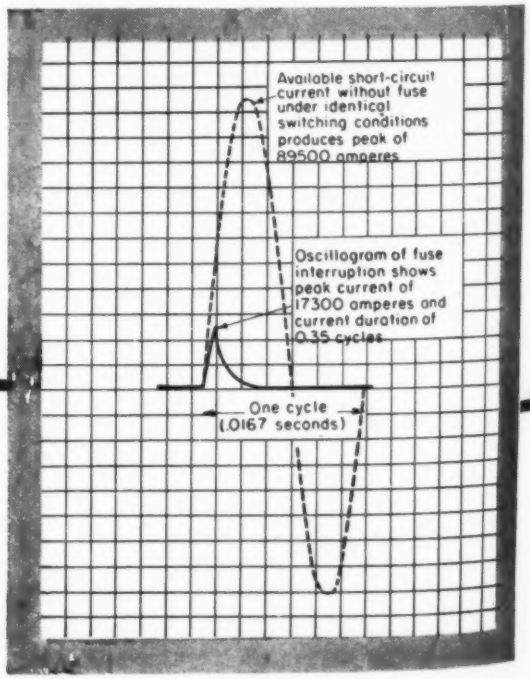
Low-cost repetitive starts ● Quick short-circuit

These easily replaceable fuses blow only on short circuits

WHAT IS LIMITAMP? Limitamp is the outstanding high-voltage motor control designed for repeated starting of large synchronous or induction motors. It is the only high-voltage motor control with air-break contactor—this means smaller, lighter moving parts, less inertia, less wear, hence longer life on repetitive operation. And because the contactor operates in air it's easy to service—no tanks to lower, no oil-handling problems. Units are completely factory-assembled in metal cabinets, and may be mounted singly or lined up to centralize all control functions in one location.

WHAT'S THE SECRET OF LIMITAMP? Secret of this high-voltage controller is the co-ordination of a new, high-voltage contactor with current-limiting power fuses for interrupting short-circuit currents. Fuses operate only under actual short-circuit conditions, and will not blow unnecessarily on motor starting or stalled current. Motor overload protection is provided by accurately calibrated isothermic relays which protect the motor from sustained running overloads, or stalled current. Limitamp controllers can be furnished with either instantaneous or time-delay undervoltage protection.

Rapid fuse action gives sure short-circuit protection, as evidenced by this oscillograph

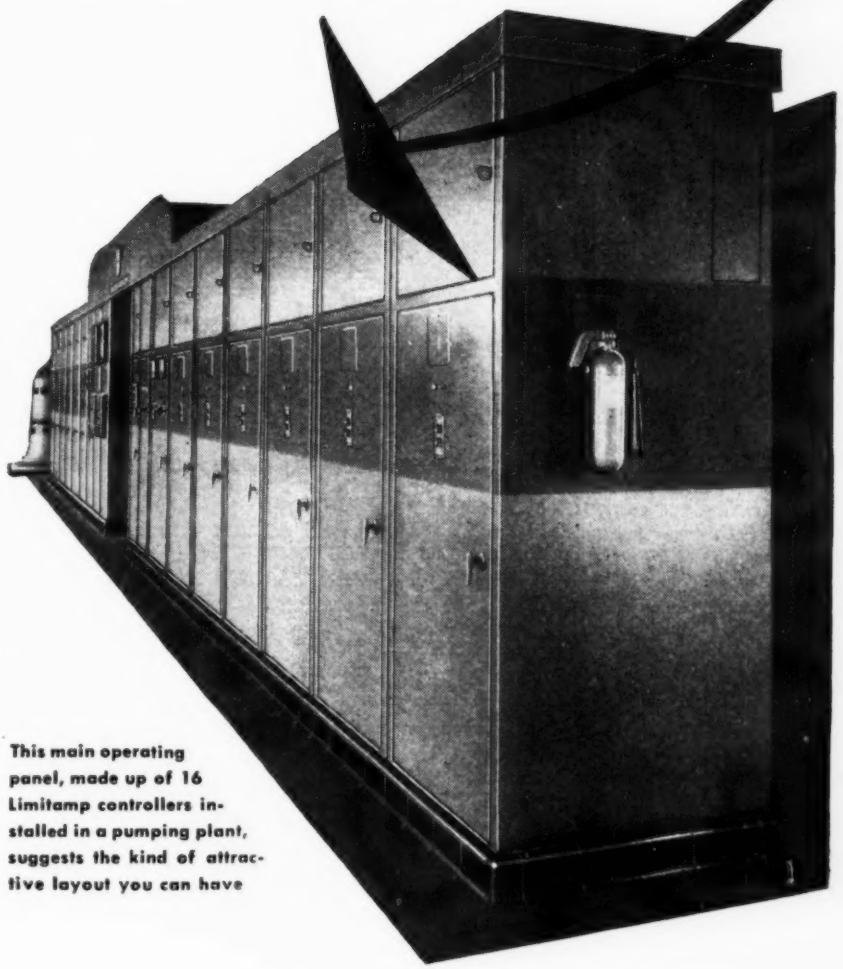

Available short-circuit current without fuse under identical switching conditions produces peak of 89500 amperes
Oscillogram of fuse interruption shows peak current of 17300 amperes and current duration of 0.35 cycles
One cycle (.0167 seconds)

interruption ● Attractive, uniform appearance

LIMITAMP control

ANY QUESTIONS? Full information on the application of Limitamp control in sewage or waterworks plants is yours for the asking from your consulting engineer or General Electric representative . . . or write for Bulletin GEA-4247.

Remember, if you elect to purchase *all* the electric equipment for your plant from General Electric, you will receive all the benefits of unit responsibility because you will be dealing with only one manufacturer . . . your engineering, buying, installation and servicing problems will be minimized. *Apparatus Dept., General Electric Co., Schenectady, N. Y.*



This main operating panel, made up of 16 Limitamp controllers installed in a pumping plant, suggests the kind of attractive layout you can have

"CLEAN WATERS" NAMED WORLD'S BEST

Chicago's Films of the World Festival recently selected "Clean Waters" as the world's best commercially sponsored motion picture! Produced by the U. S. Public Health Service and the General Electric Company, "Clean Waters" has spearheaded an effective nationwide campaign to end the pollution menace. This full-color and sound movie is available to you on a loan basis from any G-E office—see it and show it soon.

CO-ORDINATED
WATER-PLANT . . . SEWAGE-PLANT . ELECTRIFICATION

GENERAL ELECTRIC

An Official Survey

Your first reaction to the statement on the opposite page may be—"remarkable if true." For it *is* remarkable but it is also true. And it is backed by the findings of an official survey sponsored by three water works associations.

This recently completed survey shows that of all the cast iron water mains, in sizes 6-inch and larger, ever laid by 25 cities, large and small, from Canada to Florida, *96% are still in service.*

The cities were selected, and the survey directed, by a Joint Committee representing the American Water Works Association, the New England Water Works Association, and the Institute of Water Supply Utilities. The achieved purpose was to ascertain the actual length of life of various water works facilities—mains, valves, hydrants, pumping equipment, etc.

The findings are reported in detail for each city in a book published by the American Water Works Association, which ought to be "must reading" for almost everyone connected with the water works industry. Cast Iron Pipe Research Association, Thomas F. Wolfe, Engineer, 122 South Michigan Avenue, Chicago 3, Illinois.

Mr. Q-Check says:
Alexandria, Virginia, laid its first cast iron pipe in 1852 and 99% of all sizes laid from that date is still in service.

P. S.: If you are interested primarily in the survey findings as they pertain to cast iron water mains send for our brochure "Survival and Retirement Experience with Cast Iron Water Mains."

CAST IRON

CAST IRON PIPE

Backs This Statement

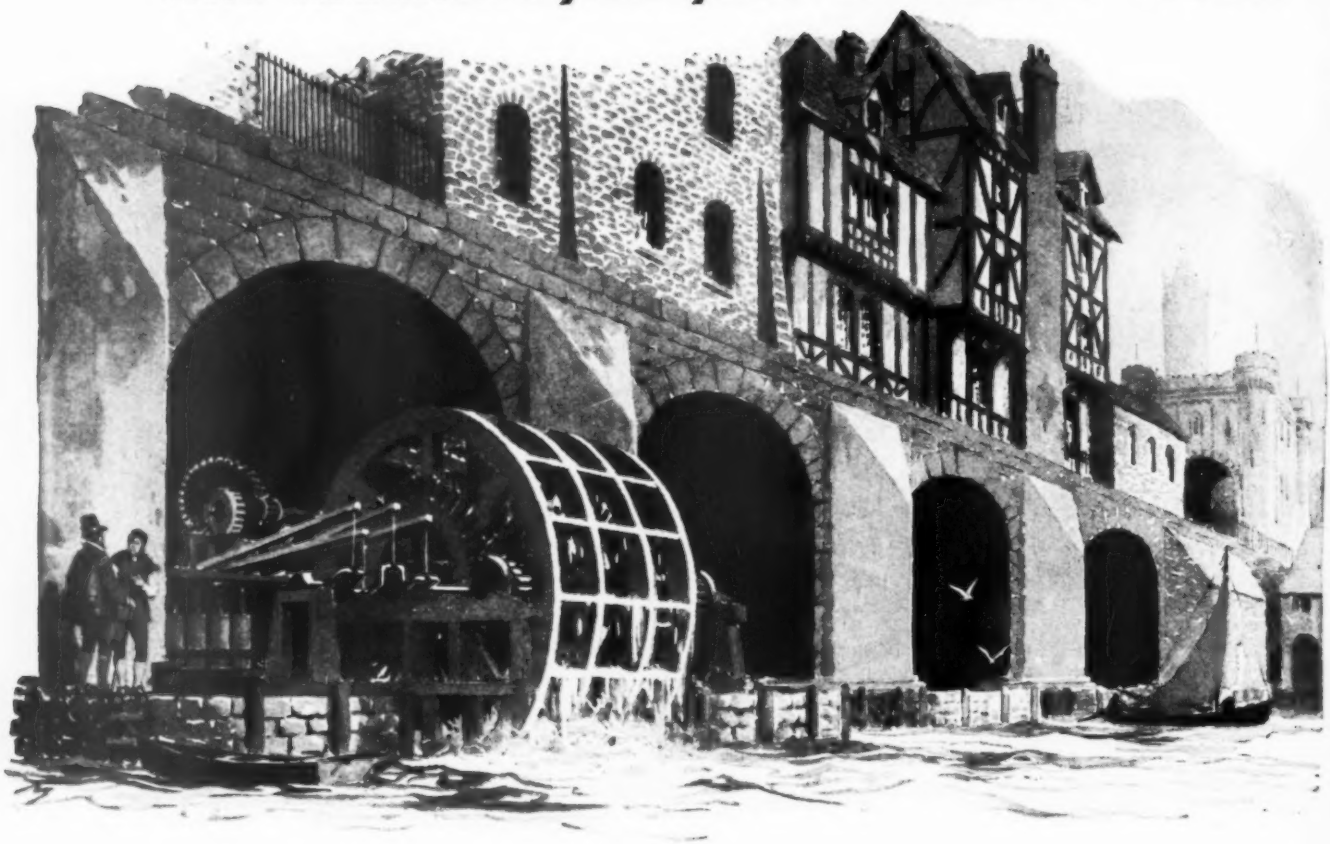
96%

Still in Service

Alexandria, Virginia
Babylon, New York
Clinton, Iowa
Clyde, New York
Denver, Colorado
Des Moines, Iowa
Detroit, Michigan
Huntington, W. Va.
Jamaica, New York
Merrick, New York
Norwich, New York
Ottawa, Ontario
Philadelphia, Pennsylvania
Portland, Maine
Rochester (Suburban), N. Y.
St. Mary's, Pennsylvania
St. Paul, Minnesota
Sag Harbor, New York
Scranton, Pennsylvania
Springfield, Massachusetts
Summit, New Jersey
Syracuse (Suburban), N. Y.
Utica, New York
West Palm Beach, Florida
Winnipeg, Manitoba

SERVES FOR CENTURIES

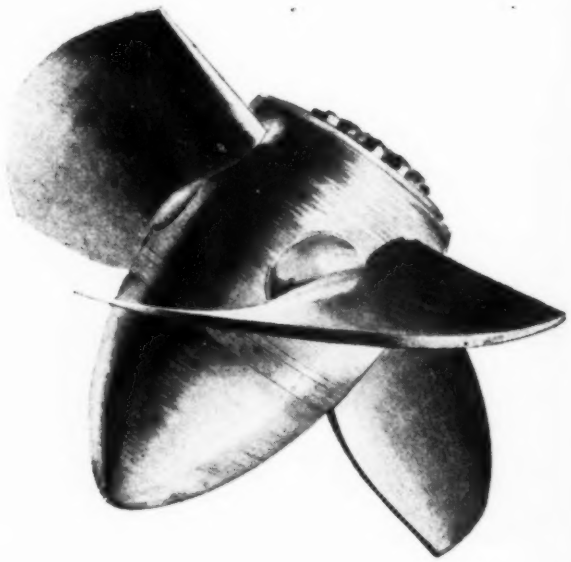
in 1582 when this machine pumped London's Water



SKIP the centuries!

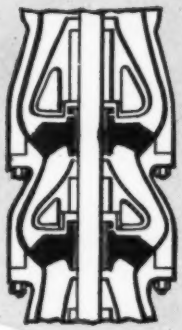
In this country alone there are systems that would shame London's great contribution, even in our smallest towns.

A Parade of Progress in which Smith Rotovalves and Axial Flow Pumps have marched in the very forefront! Good reason for putting your hydraulic problem in our hands, isn't it?

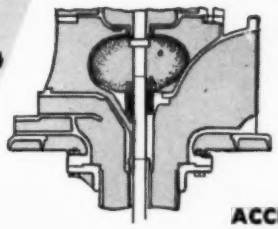


S. MORGAN SMITH Co.

YORK, PENNA. U.S.A.



OPEN IMPELLERS . . . that eliminate overloading, sand-locking and costly stoppages . . . minimize wear . . . eliminate the need for sealing or wearing rings.

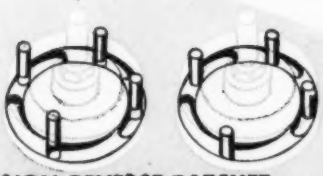


ACCESSIBLE PACKING BOX . . . located at the surface where it is easily inspected, tightened or repacked.

You Get More than Performance with POMONA!

Almost any good pump will give you performance . . . *at the start.* But Pomona Vertical Turbine Pumps give you *sustained* performance . . . consistent efficiency for years *plus* the fundamental simplicity of design that adds up to lowest operating and maintenance costs. Here's why!

ADJUSTABLE FOR CAPACITY AND WEAR. With a simple "at the surface" adjustment, capacity can be varied over a wide range without throttling. Adjustment can also be used to compensate for wear to retain peak efficiency for life.



NON-REVERSE RATCHET . . . prevents pump and motor from rotating backwards . . . eliminates possible damage to pump from accidental power reversal . . . reduces wear and maintenance.

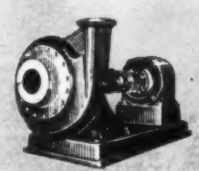
PLUS *true* water lubrication and many other important advantages your Fairbanks-Morse Pomona dealer or branch pump engineer will be glad to demonstrate. Fairbanks, Morse & Co., Chicago 5, Ill.

FAIRBANKS-MORSE

A name worth remembering

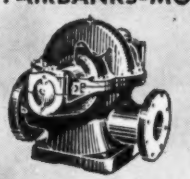
DIESEL LOCOMOTIVES • DIESEL ENGINES • PUMPS • SCALES • MOTORS • GENERATORS
STOKERS • RAILROAD MOTOR CARS and STANDPIPES • FARM EQUIPMENT • MAGNETOS

A FEW OF THE COMPLETE LINE OF FAIRBANKS-MORSE PUMPS

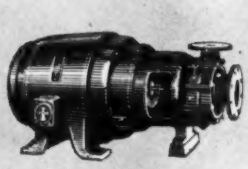


Trash Pumps

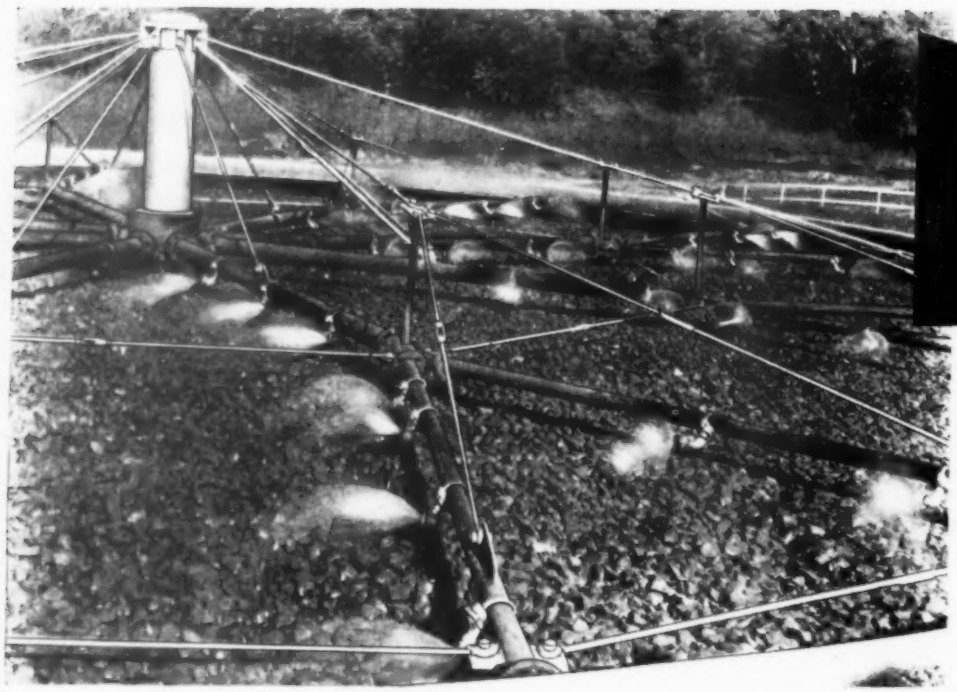
Side-Suction



Centrifugals



Builtogether



HIGH

IN PURIFYING EFFICIENCY

LOW

IN COST

YEOMANS

"Aero-Filter" SYSTEM

for sewage and waste treatment

In more than 100 installations the Yeomans "Aero-Filter," a high capacity biological trickling filter, is establishing remarkable records for an unusually high degree of purification at exceptionally low cost.

Note these seven important advantages:

1. Rain-drop distribution is highly efficient, which eliminates all need for costly recirculation for dilution purposes.
2. Single-stage operation produces a clear effluent; and reductions of raw sewage BOD ranging from 80% to 85% are common.
3. Two-stage operation is regularly obtaining reductions of raw sewage BOD ranging from 90% to 94%.
4. Construction cost is remarkably low, since the Aero-Filter bed is about one-eighth the size of a standard rate filter bed for equal capacities.
5. Operating cost is the lowest of all types of complete sewage treatment—no additional pumps, motors, tanks, etc., for recirculation.
6. Uninterrupted and almost complete momentary bed coverage minimizes troubles from odors, freezing, ponding and filter flies.
7. All returns are made direct to the filter—therefore an oversize primary tank to accommodate recirculation is unnecessary.

The "Aero-Filter" can be fitted to any requirements, from small units up to large treatment works. Accurate cost estimates and complete engineering data are readily obtainable—simply write us.

For treating industrial waste, the Aero-Filter has proved ideal—

High Loading—especially important in treating exceedingly strong waste.

Economy of Space—the filtration bed is much smaller than in other types of treatment plant.

Low Cost—economical to install, costs much less to operate—owing largely to absence of recirculation for dilution.

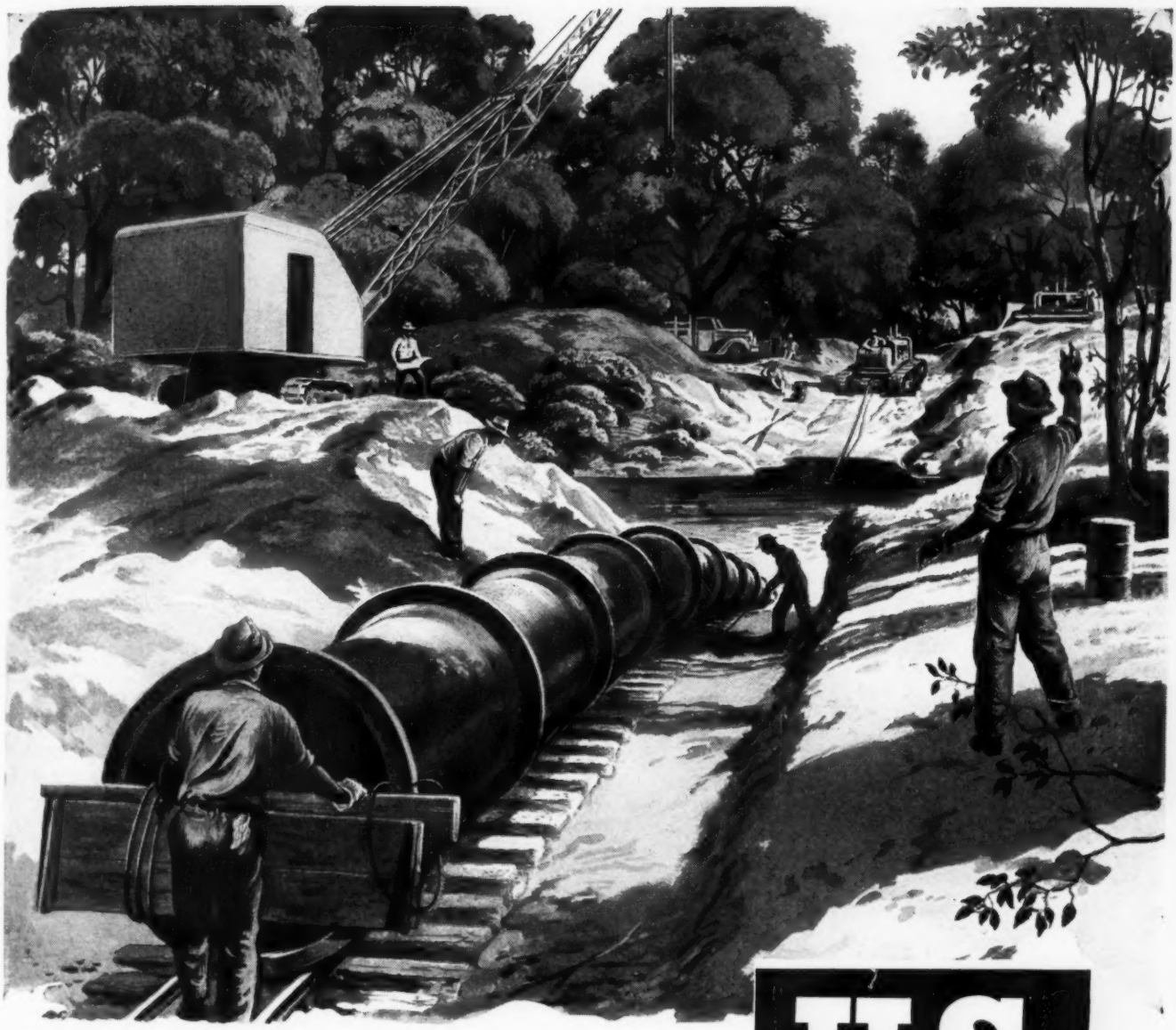
YEOMANS BROTHERS COMPANY

1423 NORTH DAYTON ST.
CHICAGO 22, ILLINOIS

For the handling and treatment of domestic sewage and industrial waste, Yeomans manufactures: Yeomans Aero-Filter—high capacity trickling filter ● Yeomans "Package" Aerifier—activated sludge process ● Rectangular and circular Sludge Collectors ● Digesters ● Centrifugal and pneumatic Sewage Ejectors ● Scum, Grease and Sludge pneumatic Ejectors ● Rotary Distributors ● Plunger Sludge Pumps.

1898 **YEOMANS** 1948

50 YEARS OF PUMP EXPERIENCE



Painted for U. S. Pipe & Foundry Co. by Paul Laune

U.S. PIPE

In the files of our Engineering Service Department that go back nearly half a century, are records of the solutions to unusual problems in pipe design and installation, such as the flexible joint stream crossing illustrated above. If you have such a problem we may be able to tell how a **similar** problem was previously solved. Our wide design and manufacturing experience with special fittings to meet unusual requirements, where standard material cannot be used, may also be found of value to you. **United States Pipe and Foundry Co., General Offices: Burlington, New Jersey. Plants and Sales Offices Throughout U. S. A.**

Engineering Facts about

Johns-Manville TRANSITE PRESSURE PIPE

The Inyokern Earthquake

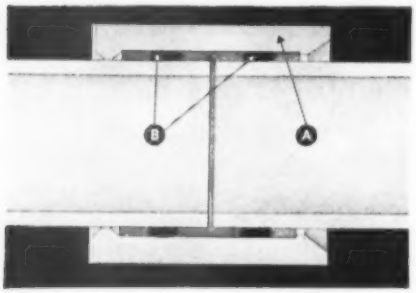
WATER LINES are seldom required to withstand a test as severe as that to which a Transite* asbestos-cement Pipe installation was subjected at Inyokern, California, about two years ago. The Transite installation at Inyokern consists of over 300,000 feet of pipe and comprises the major portion of the water supply system for the vast Naval Ordnance Test Station located there.

During the early part of 1946, an earthquake of maximum intensity occurred in the Inyokern area. Shocks of great severity were felt throughout the immediate locality in which the Transite line was laid. Naturally, concern was felt at the Naval establishment for the safety of its water supply.

After the quake had subsided, crews were dispatched to repair whatever damage the lines might have suffered. A thorough search failed to reveal a single break or any evidence of leakage at any one of the 25,000 joints in the system. Subsequent careful check of pressures and measurement of water levels confirmed that the lines had remained intact.

This aerial view shows a portion of the Naval Ordnance Test Station at Inyokern, California.

The reason this Transite installation was able to withstand this severe test is found in the inherent strength of the pipe and in the design of its Simplex Coupling, the standard coupling for Transite Pressure Pipe. Each of these couplings is a tight yet flexible link connecting one section of pipe to another and imparting to the line as a whole a degree of flexibility which enables it to "roll with the punch." Thus, shocks and vibrations are absorbed, stresses minimized to an unusual degree.



This cutaway sketch shows construction of the Simplex Coupling used with Transite Pressure Pipe. It consists of Transite sleeve "A" and two rubber rings "B" which are tightly compressed between sleeve and pipe as the coupling is assembled.

A factory-made joint which requires only assembly on the job, the Simplex Coupling derives its flexibility from its simple design. Consisting of a Transite sleeve and two rubber rings tightly compressed between pipe and sleeve, its simplicity and ease of assembly are apparent from the accompanying illustration. Moreover, this coupling is readily checked for proper assembly as the line is laid—further assurance of tightness in each individual joint and in the line as a whole.

Probably your water lines will never be called upon to absorb punishment as severe as the Transite lines at Inyokern. But the same engineering advances which protected this Transite installation can be depended on to safeguard equally well against the stresses normally encountered in water line service.

For further information about Transite Pressure Pipe, write Johns-Manville, Box 290, New York 16, N. Y.

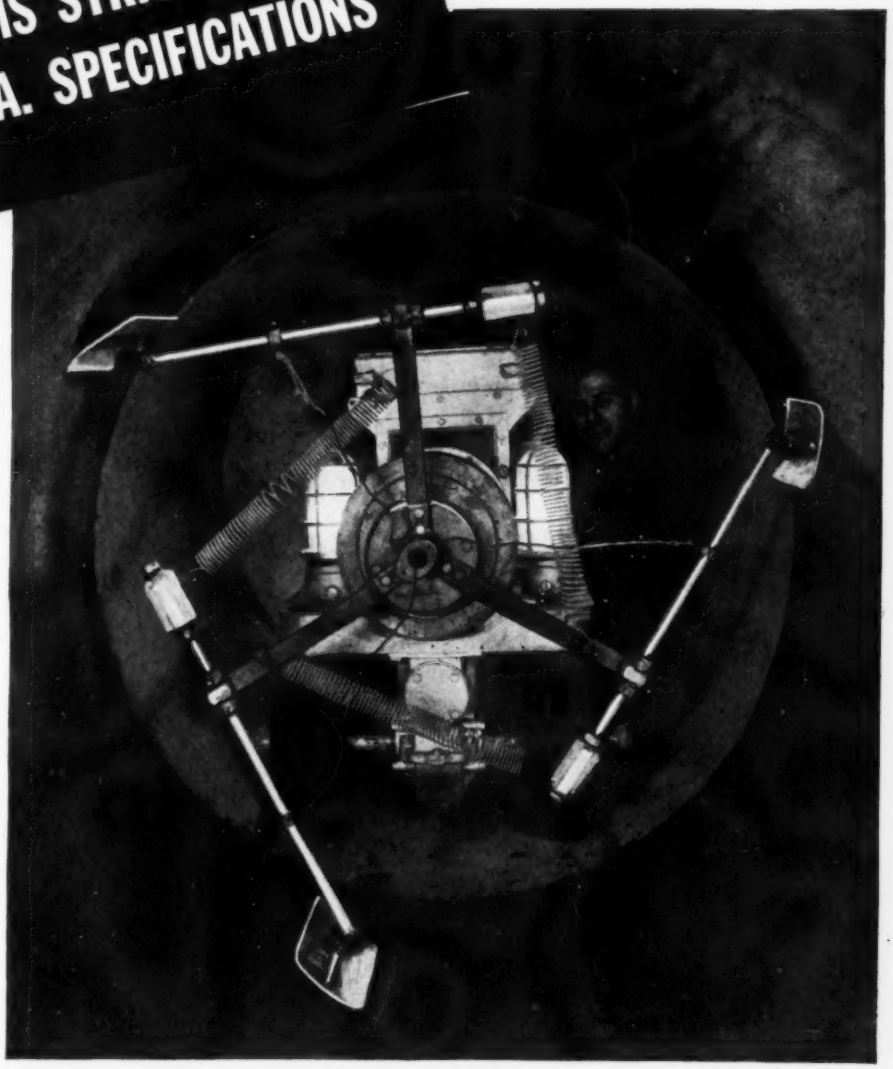
JOHNS-MANVILLE JM PRODUCTS

*Transite is a registered Johns-Manville Trade Mark

CENTRILINE

CONFORMS STRICTLY WITH A.W.W.A. SPECIFICATIONS

▶▶▶ PIPE LINING FACTS NO. 3



▶▶▶▶ The Standard Specifications for cement-mortar protective coatings issued by the American Water Works Association provide: "Interior of the entire line, including both curves and tangents, shall be by centrifugal machine . . . the machine shall apply the mortar by centrifugal action without the use of compressed air and follow its application by automatic trowelling to a uniform thickness and smooth finished surface."

The strict adherence to these specifications by Centriline insures a continuous, dense, smooth lining, applied without rebound that means restored carrying capacity perpetually sustained and longer life to mains. If pipelines are losing efficiency it is time to consider Centrilining. Our engineers stand ready to assist you.

▶▶▶▶ WRITE TODAY FOR THE NEW CENTRILINE CATALOG

CENTRILINE CORPORATION

148 CEDAR STREET • NEW YORK 6, N. Y.

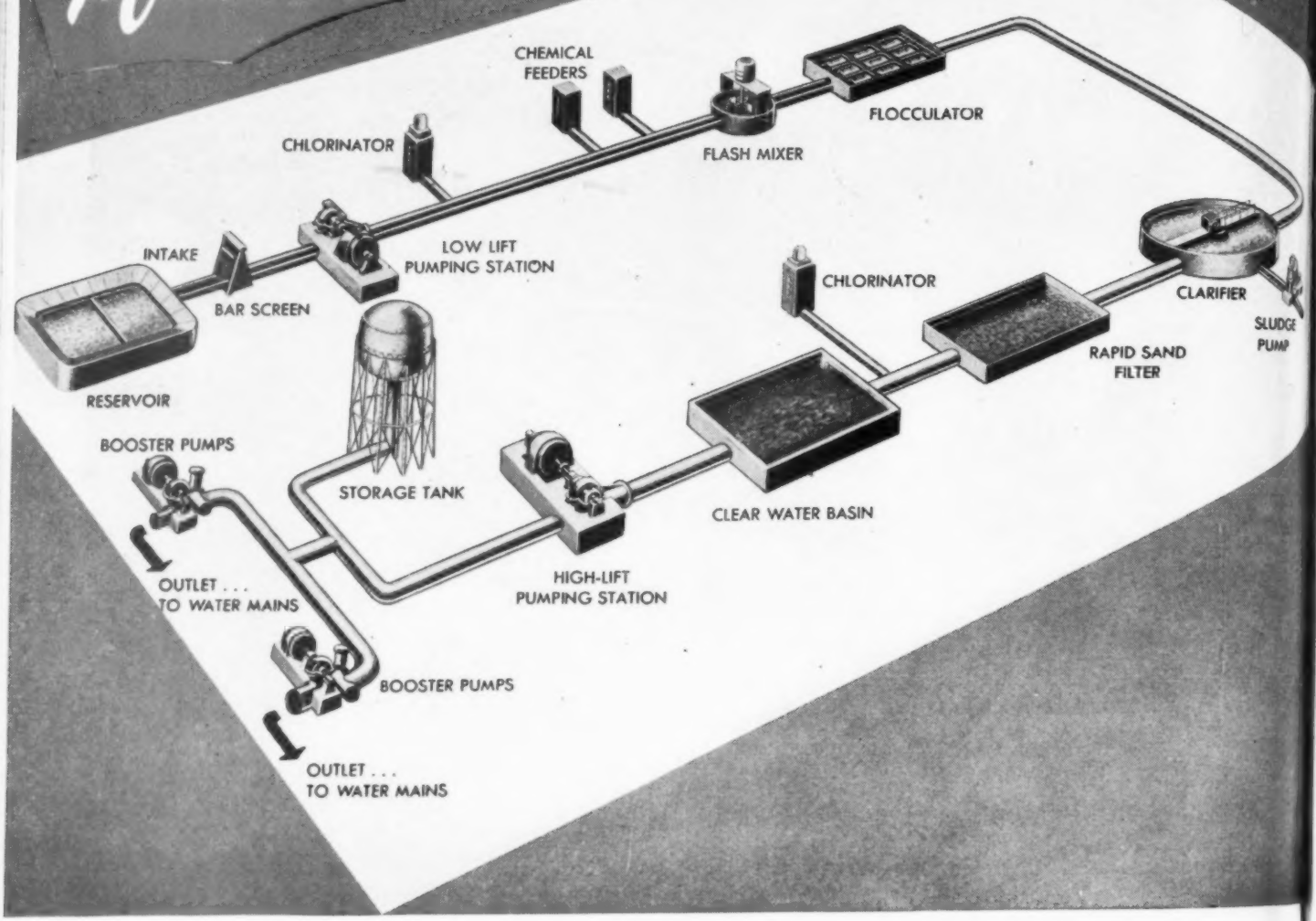
CENTRILINE PROCESS

CEMENT MORTAR LININGS FOR WATER MAINS

Centrifugally Applied

In Strict Conformity with A. W. W. A. Specifications

Unit Responsibility KEY TO MORE



"A TO Z" SOLUTION TO YOUR ELECTRICAL OR POWER REQUIREMENTS . . . *FOR HIGHER OPERATING EFFICIENCY*

Whether your plans call for expansion, modernization or a completely new plant, you will find advantages in using the Westinghouse background in waterworks engineering—regardless of the size of the contemplated project.

Westinghouse engineers will work with you to obtain highest operating efficiency through the proper *selection, application* and *co-ordination* of the complete electrical drive.

Westinghouse equipment will provide you assurance of long-time, trouble-free service.

Westinghouse servicing will minimize and simplify your maintenance problems.

Typical of case histories where Westinghouse waterworks engineering has been job-proved is the City of Dallas 120 mgd Bachman plant, which is completely Westinghouse-electrified.

For help on your waterworks drive problem, call your Westinghouse office, or write today to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-94746

E OPERATING EFFICIENCY

"WESTINGHOUSE-EQUIPPED THROUGHOUT" MEANS SIMPLIFIED ORDERING, QUICKER INSTALLATION, MORE EFFICIENT OPERATION

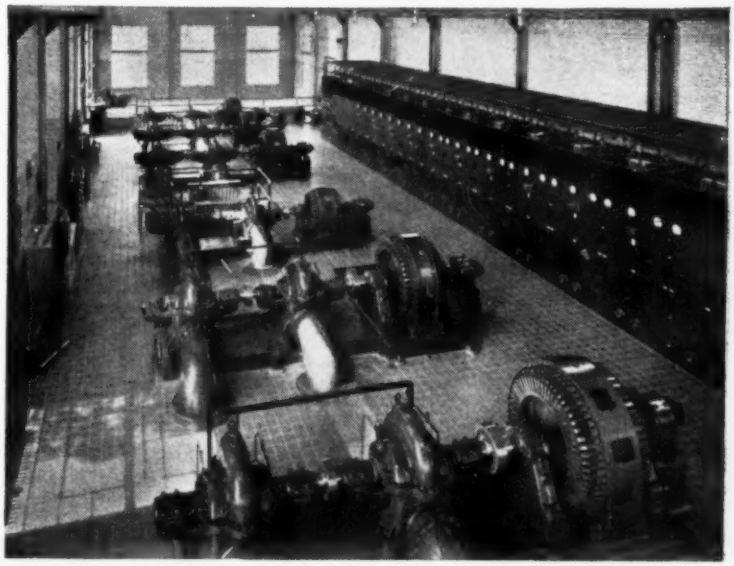
Putting power to work *efficiently* can be a major problem—or a simple one. When items must be selected, ordered and received from many sources, it means many chances for costly errors and delays . . . divided responsibility—or none at all—for performance of installed equipment.

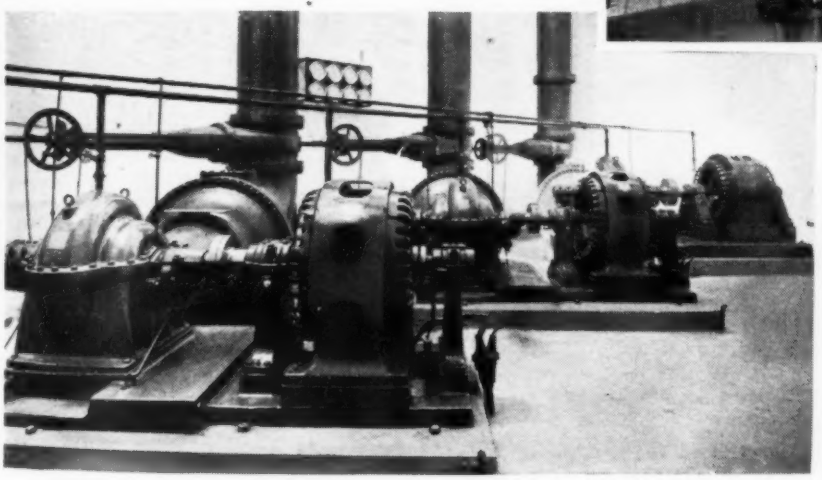
Westinghouse offers the way to simplify the job. From equipment for generation of electrical or steam power, to the most specialized types of drives and control for its utilization, Westinghouse provides a single source of supply . . . one broad pair of shoulders competent to take responsibility for performance of all parts of the job.

Here is one of many examples where Westinghouse unit responsibility is preventing headaches . . . saving money . . . assuring *higher operating* efficiency:

MAIN PUMPING FLOOR of the 120 mgd Bachman Waterworks, City of Dallas, Texas. This plant has 15,225 hp in Westinghouse motors, supplemented by Westinghouse switchgear and other apparatus. The satisfactory service rendered is evidenced by 12 years' operation without repairs of any kind to electrical equipment, with a maintenance cost which has averaged less than 2c per hp.

In the center are five 800-hp and one 400-hp Westinghouse synchronous motors. At the left and right-rear two Westinghouse motor generator sets (one of which is a standby unit) furnish excitation for four 500-hp and three 900-hp Westinghouse motors located in the basement. At the right is shown part of the Westinghouse controls for the entire plant.





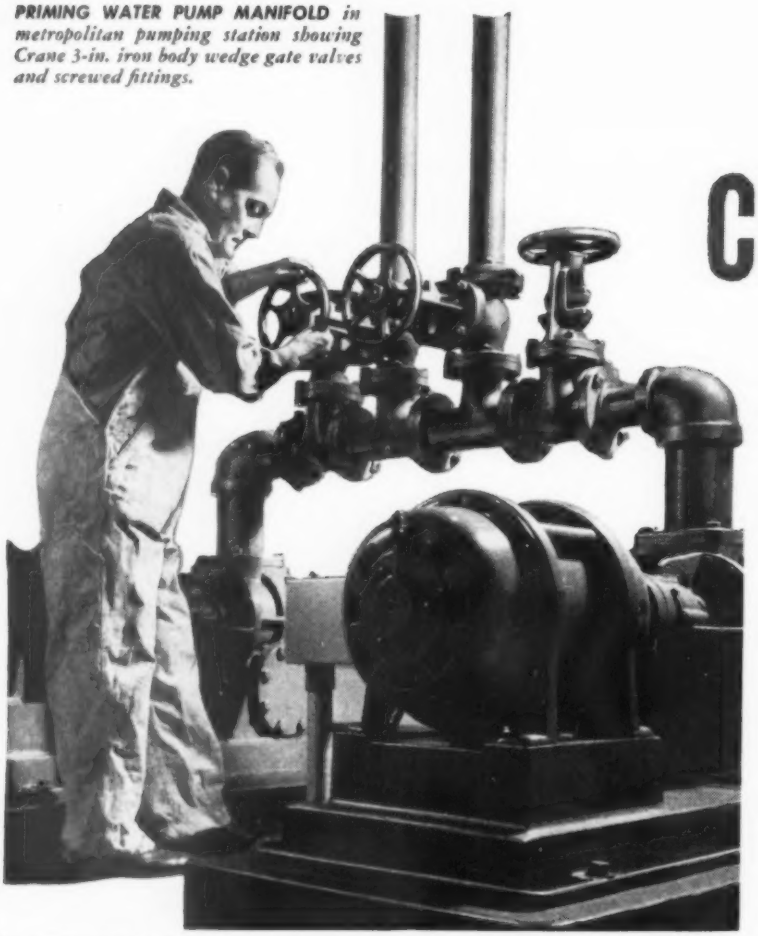
LEFT: Basement floor, showing three of four 500-hp Westinghouse motors, each of which drive a 30 mgd raw-water pump. Three 900-hp Westinghouse vertical motors, driving clear-water pumps, are also located on this floor but are not seen in this picture.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

MORE PRODUCTIVE POWER FOR INDUSTRY

PRIMING WATER PUMP MANIFOLD *in metropolitan pumping station showing Crane 3-in. iron body wedge gate valves and screwed fittings.*



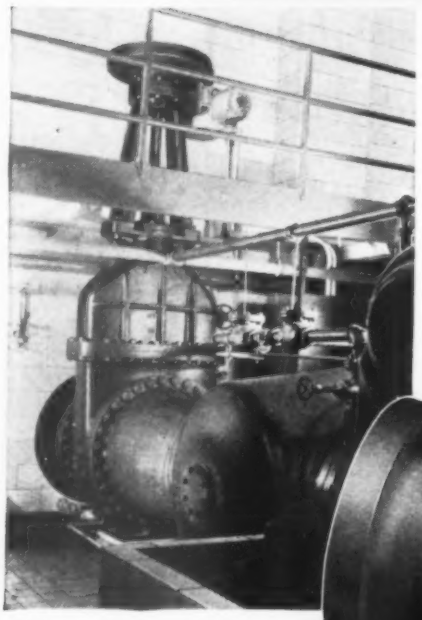
crane valves

a sound investment for any community

In city, suburb, or town . . . in water supply or sewage disposal plant . . . men responsible for public water services continue to rely on Crane. And with good reason. They know Crane Co.'s well established reputation for supplying municipalities with the correct flow control equipment.

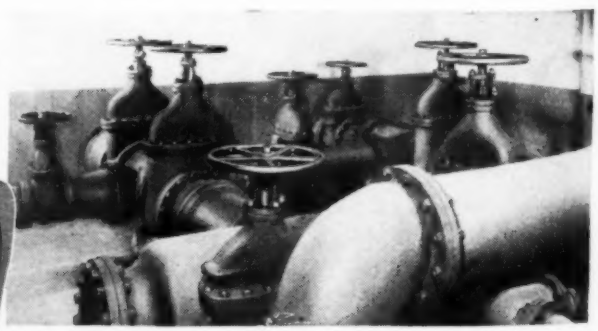
Crane valves, by their dependable performance under all operating conditions, help maintain water utilities at peak efficiency. Crane Quality—in fittings as in valves—minimizes the need for repair and replacement. No wonder so many communities point with pride to their investment in Crane piping materials.

Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.
Nation-wide Service Through Branches and Wholesalers



MOTOR-OPERATED *36-in. Crane gate valve on pump discharge in a large water system. Crane supplies all types of remote controls for valves.*

A.W.W.A. GATE VALVES BY CRANE *offer smooth and positive control for water mains and distribution lines. Crane No. 480½ double disc iron gate valve shown here is brass trimmed; has non-rising stem; hub ends. Sizes up to 12-in. rated at 200 pounds; sizes 14 to 36-in., at 150 pounds. See your Crane Catalog, p. 126.*



RAW WATER INLET *lines in large sewage treatment plant featuring Crane low-pressure iron body double disc gate valves.*

VALVES · FITTINGS · PIPE

CRANE

PLUMBING AND HEATING

The Bettmann Archive

Knowing how is simply the sum of experience, resources and imagination, put into the job of doing something better.

Niagara Alkali Company pioneered the electro-chemical industry in America. Niagara continues to extend the know-how gained in this pioneering work to the many users of Niagara Caustic Soda, Caustic Potash, Carbonate of Potash, EBG Liquid Chlorine, Paradichlorobenzene and Niagathal (Tetrachloro Phthalic Anhydride). May we serve you?

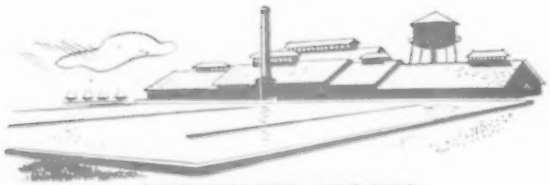
NIAGARA ALKALI COMPANY

60 East 42nd Street, New York 17, N.Y.

LIQUID CHLORINE • CAUSTIC POTASH • CARBONATE OF POTASH • PARADICHLOROBENZENE • CAUSTIC SODA • NIAGATHAL (TETRACHLORO PHTHALIC ANHYDRIDE)

GENERAL CHEMICAL "ALUM"

...Equally Efficient for Coagulation of WATER and SEWAGE!



FOR WATER WORKS

1. Produces crystal clear water.
2. Gives better floc formation.
3. Promotes better settling and longer filter runs.
4. Aids in reduction of tastes and odors.
5. Has no chlorine demand.
6. Is a *low cost* coagulant.
7. Superior in tests against other coagulants.
8. High in quality. Its constant uniformity can be depended upon.

FOR SEWAGE PLANTS

1. Clean, easy to handle.
2. Dry feeds well or dissolves readily for solution feeding.
3. Simple application. Requires only low cost feeding apparatus and minimum attention.
4. Clear, colorless effluents are possible.
5. Sludge digests readily.
6. Treated digested sludge dries quickly with minimum of odor.
7. Chlorine consumption is cut due to lower demand of clarified sewage.
8. Economical to use.

Aluminum Sulfate is almost universally accepted by water experts as the best coagulant for removal of turbidity, color and bacteria from water . . . and General Chemical Aluminum Sulfate is the outstanding choice the nation over. That's because its high quality and constant uniformity have given it a time-tested reputation for reliability among operating men in towns and cities all over America.

Municipal officials in charge of sewage treatment also find that clarity of sewage effluent is easily obtainable with General Chemical Aluminum Sulfate for the many reasons outlined above. For your water and sewage disposal systems, specify General Chemical "Alum"—*preferred by most American cities.*

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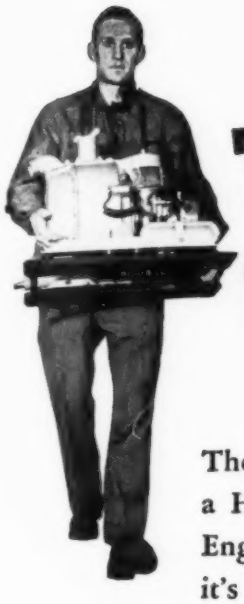

The One Carryable Pump for all jobs

There's one thing about a Homelite Gasoline-Engine-Driven Pump... it's small enough to get to a job and big enough to *do* the job. But that's not all... not by far. A Homelite... *and only a Homelite* ...has 9 Big Features that make it the best pump for all jobs... your jobs.

The Best Pump for All Jobs is the Pump with All These Features		
1	CARRYABILITY	√
2	FAST SELF-PRIMING	√
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4	HIGH 28-FOOT SUCTION LIFT	√
5	NON-CLOGGING DESIGN	√
6	MAINTAINED RATED CAPACITY	√
7	DISCHARGE PRESSURE	√
8	DEPENDABILITY	√
9	SIMPLE DESIGN AND OPERATION	√

Handles Mud and Sand Easily

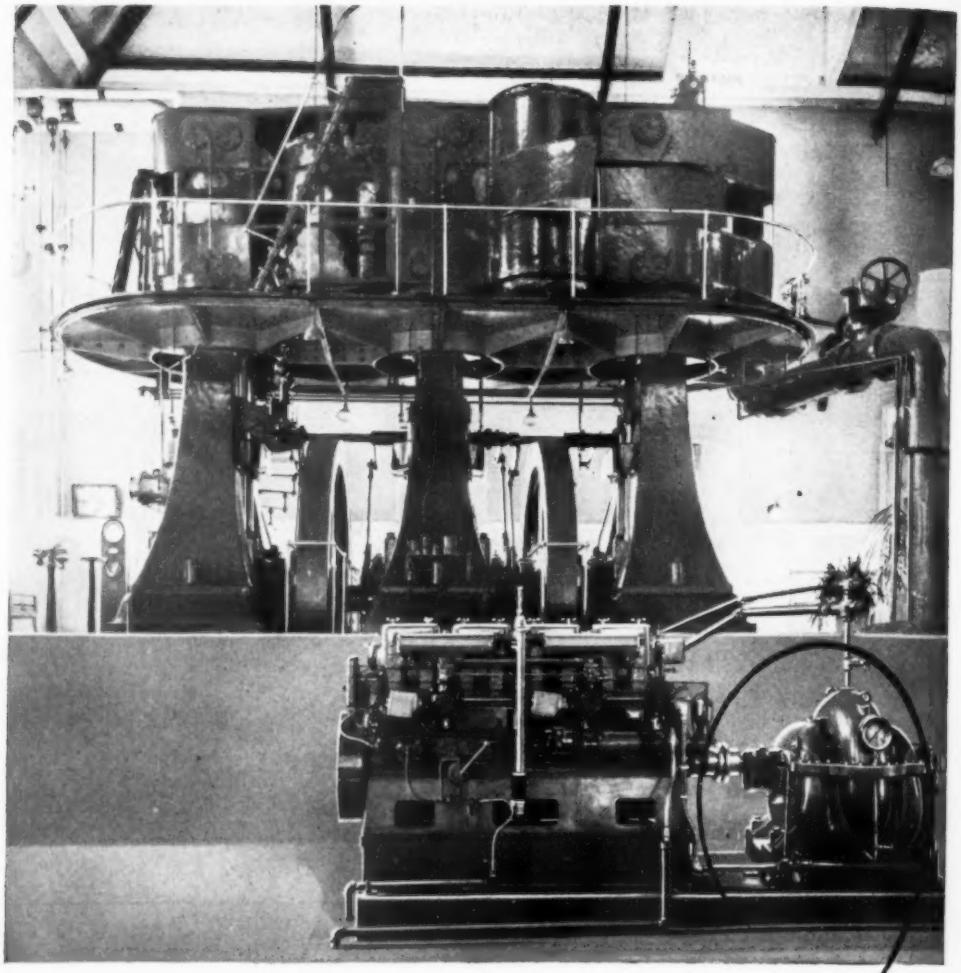
Non-clogging, self-scouring, with no pockets to accumulate solids, a Homelite *Carryable* Pump handles the thickest and muddiest water without stoppage or shutdowns for cleaning.

See for yourself

Write today for our new illustrated bulletin No. L-503 that tells the *complete* story and shows how you can get faster, better pumping with Homelite *Carryable* Pumps.

HOMELITE
CORPORATION
710 RIVERDALE AVENUE, PORT CHESTER, NEW YORK

MANUFACTURERS OF HOMELITE *CARRYABLE* PUMPS · GENERATORS · BLOWERS · CHAIN SAWS



New De Laval Centrifugal Pump

REPLACES OBSOLETE GIANT

as Atlantic City modernizes

Replacement of the old triple-expansion pumping engine, shown in the background with the new De Laval centrifugal pump in the foreground, is part of the modernization program for Atlantic City. This station now employs a total of seven De Laval centrifugal pumps having a combined capacity of more than 73 million gallons daily. Four of these are motor-driven pumps employed for practically continuous operation while three are gasoline engine-driven pumps employed for stand-by service. All seven units are equipped with self-priming systems so that they can pick up the load upon a minute's notice.

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DE LAVAL STEAM TURBINE CO., TRENTON 2, N.J.

Atlanta • Philadelphia • Los Angeles • Chicago • Pittsburgh • San Francisco
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WW-6

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

SPECIFY INFILCO EQUIPMENT

FOR SEWAGE and WASTE TREATMENT

The Infilco Field Engineer offers you complete facilities, complete service, unbiased recommendation to meet every problem because Infilco equipment covers every phase of water, sewage and waste treatment.

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TYPICAL OF INFILCO LEADERSHIP

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Water Conditioning and Sewage Treating Equipment

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FIRST for Over FIFTY YEARS

Write or Call nearest Field Engineer or Chicago Headquarters

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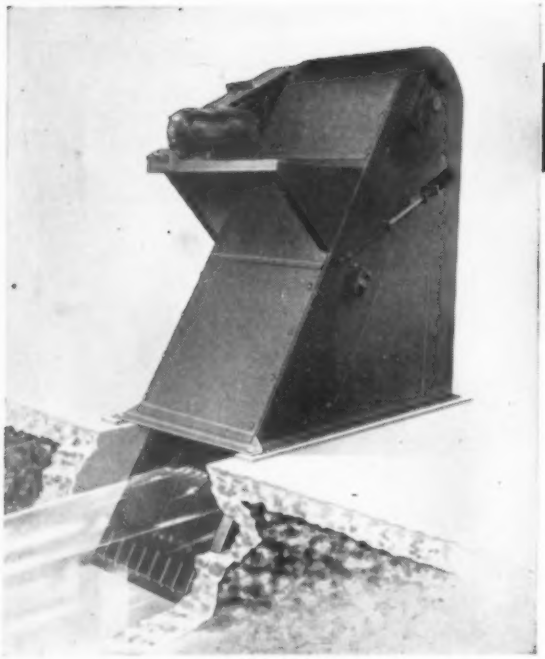


Here's a cutaway view of a type MI Screen, showing typical construction and placement in channel. Note that all operating parts are fully enclosed, yet are readily accessible.

You can see the straight, unobstructed approach channel in this cutaway photo of the type MA Screen. Rex Bar Screens can be built to suit practically any channel dimension.

DON'T TAKE OUR WORD FOR IT

. . . just ask the commissioners of sanitation

and the superintendents of plants from coast to coast. They'll all say the same thing—that Rex Mechanically Cleaned Bar Screens are unequalled for long life, efficient performance, and economical operation.

These bar screens have gained their reputation for superiority in all sizes, from .1 to 150 MGD. Used in the majority of installations in the country, they have set new standards for efficiency, low head loss, low-cost installation and operation, and durability. Their neat, streamlined design adds to the appearance of any plant . . . makes cleaning fast and easy.

Highest quality materials, precise workmanship, and experienced engineering know-how combine to assure you the utmost in long years of satisfactory performance.

For all the details on exclusive features, easy installation, and application advice, write to Chain Belt Company, 1610 W. Bruce St., Milwaukee 4, Wis.

A Few Reasons For REX Superiority

- *Unobstructed flow to rack—guarded chain—streamlined sprockets.*
- *Heavy bar rack without obstructing cross-members—bars rigidly fastened and accurately spaced.*
- *Generous rake width—high capacity.*
- *Special rake teeth accurately machine cut from heavy steel plate—designed to clean top and sides of bars to full depth.*
- *Rigid rake mounting with stiff-back links—no latches or pivots—rake cannot slide over accumulated screenings.*
- *Positive rake cleaner—quiet and adjustable.*
- *Rex Z-Metal Chain and attachments—corrosion and wear resisting.*
- *Split head-sprockets—easily removable.*
- *Special protection for important wearing parts—corrosion resisting.*
- *Drive unit fully enclosed—efficient—shear pin protection against overload.*
- *Head end of screen fully enclosed—rugged design—neat appearance—easy removal of screenings.*

CHAIN BELT REX COMPANY

SANITATION EQUIPMENT

TRADE DARLING MARK

HYDRANTS

...many types and sizes but only one high standard of performance!

Standard, one-piece barrel

Quikfix, breakable coupling type

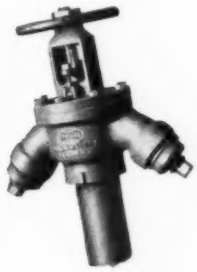
Flange above ground-line type

With outside independent hose nozzle valves

Tee-base type

Water crane type

Flush type



Tropical type

YES, there's a Darling hydrant that's just right for practically every known requirement. A few of the different types are shown here. All have one thing in common ... performance at its efficient, low-cost best!

Here's a point to bear in mind. The basic design features that pay off so well in Darling-equipped towns, are applied to all but one of the various Darling types. Many of the working parts are interchangeable . . . planned that way for the sake of user economy, simplified maintenance and low inventory.

Do you have locations where frequent traffic damage is the rule? Are there other places where concealed flush-type hydrants would be ideal? Perhaps there are points where Darling's practical Tee-base type can save you money. And how about future fills and grade changes?

Why not let a Darling engineer explain how effectively, how *economically* your particular service conditions can be met with modern Darling hydrants? Or, if you prefer, we'll gladly send you Catalog 17M. It describes all the various features, types and sizes in complete detail.

TRADE DARLING MARK

DARLING VALVE
& MANUFACTURING CO.
Williamsport 11, Pa.

Richmond, Va. Builds New Storm Sewer with CONCRETE PIPE

THE NUISANCE and traffic hazards that resulted from excessive surface drainage in the 270-acre Westover Hills-Forest Hill Terrace area of Richmond, Va. are being corrected with a new storm sewerage system made of concrete pipe. In all, 13 sizes of pipe are used in this project—ranging from 12″ to 24″—ASTM C14-41 plain concrete pipe and from 27″ to 84″—ASTM C75-41 reinforced concrete pipe.

Concrete pipe lines give safe, strong, durable, and economical service for sewerage, drainage and water lines. Concrete pipe provides maximum hydraulic capacity. Tight joints and uniformly dense concrete insure minimum infiltration and leakage. First cost is moderate and the many years of service result in ***low annual cost.***

•

The Westover Hills-Forest Hill Terrace project was designed by the City of Richmond and directed by Gamble M. Bowers, Director of Public Works, and supervised by E. L. Clements, Chief of the Bureau of Sewers and Structures, Department of Public Works. Photos, courtesy Richmond Department of Public Works.

AMERICAN CONCRETE PIPE ASSOCIATION

228 NORTH LASALLE STREET, CHICAGO 1, ILLINOIS

Calgon*

eliminates red water

**T. M. Reg. U. S. Pat. Off.*

HAGAN HALL BUROMIN CALGON

calgon, inc.

A SUBSIDIARY OF HAGAN CORPORATION

HAGAN BUILDING PITTSBURGH 30, PA.

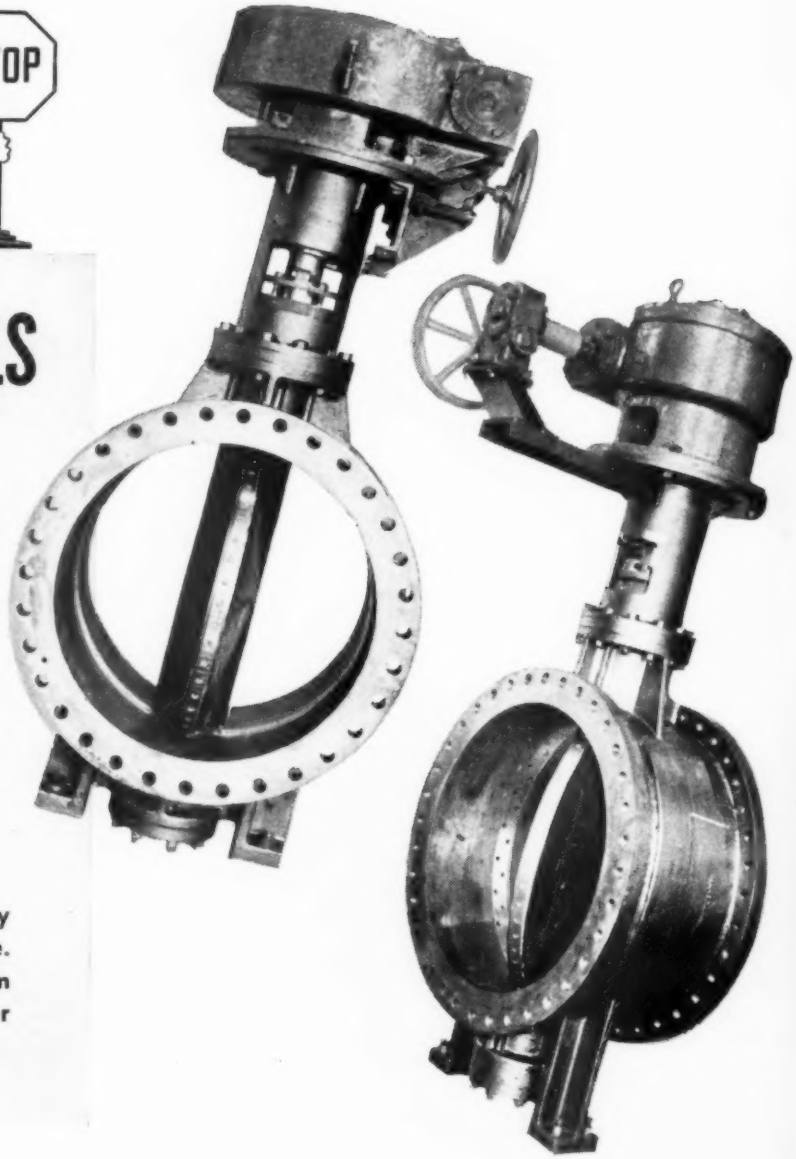
TRAFFIC CONTROLS

for San Diego water supply

fitted with *Everdur*

AND BRONZE

Key parts of these 36" and 42" butterfly valves are made of Everdur and Bronze. Valves made by Coldwell-Wilcox Division of Krajewski-Pesant. Hydraulic Engineer for the city of San Diego: Fred D. Pyle.



DOWN from the Alvarado Regulating Reservoir rushes the water supply for San Diego, California, under 100 lb. pressure. Among the controls for this man-made underground river are these two butterfly valves, 36" and 42" I.D., which together weigh 16,000 lbs.

Many vital parts of these valves are made of Everdur* Copper-Silicon Alloys to insure long, dependable service. The shafts (respectively 5" and 5½" diam.) and seating rings in the body and in the disc are of Everdur. The ⅝" seating rings are fastened with Everdur screws. The stuffing box followers are of bronze with Everdur bolts throughout.

Why was Everdur chosen for this critical service? Because these famous alloys have proved thoroughly reliable in hundreds of water and sewage works applications. As a group, Everdur Alloys combine excellent corrosion resistance with high tensile strength, high fatigue limit, and good workability by all methods, including welding.

It pays to be familiar with the many ways in which you can take advantage of Everdur Alloys. For detailed information, write for Publications E-11 and E-5. 48184

*Reg. U. S. Pat. Off.

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from mine to consumer

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Grit & Sludge Removal, Screening and Mixing Equipment Headquarters

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SANITARY ENGINEERING EQUIPMENT by LINK-BELT
for WATER SEWAGE AND INDUSTRIAL LIQUIDS TREATMENT

LINK-BELT *Booths Nos. 15, 16, 17. . . . . F. S. W. A. Convention, Detroit, Oct. 18-21*

Shown above is part of the Link-Belt exhibit at the 1947 Federated Sewage Works Association Convention held at San Francisco.

At this year's convention, we will occupy three booths. The first section will cover grit removal and sludge collection equipment featuring the Link-Belt Straightline grit chamber and Straightline sludge collectors.

The second section will be devoted to screening methods and equipment such as Link-Belt Straightline bar screens, trash screens, Tritor screens and vibrating screens. Link-Belt mixing equipment to be featured will be the Link-Belt line of flash mixers and Link-Belt vertical slow and horizontal slow mixers.

Another part of the exhibit will cover Link-Belt power transmission machinery which consists of a complete line of ball and roller bearings, silent and roller chain drives, speed reducers, variable speed transmissions and the Electrofluid Drive.

The entire exhibit has been designed to give you valuable knowledge and expert advice on all of these subjects. We sincerely hope you will plan to visit with us.

LINK-BELT COMPANY

Philadelphia 40, Chicago 9, Indianapolis 6, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities. 11,274

IRON REMOVAL

equipment for all water supplies—

Iron is objectionable! The U. S. Public Health Service Drinking Water Standards state that the iron (Fe) and manganese (Mn) content together shall not exceed 0.3 ppm for general household use.

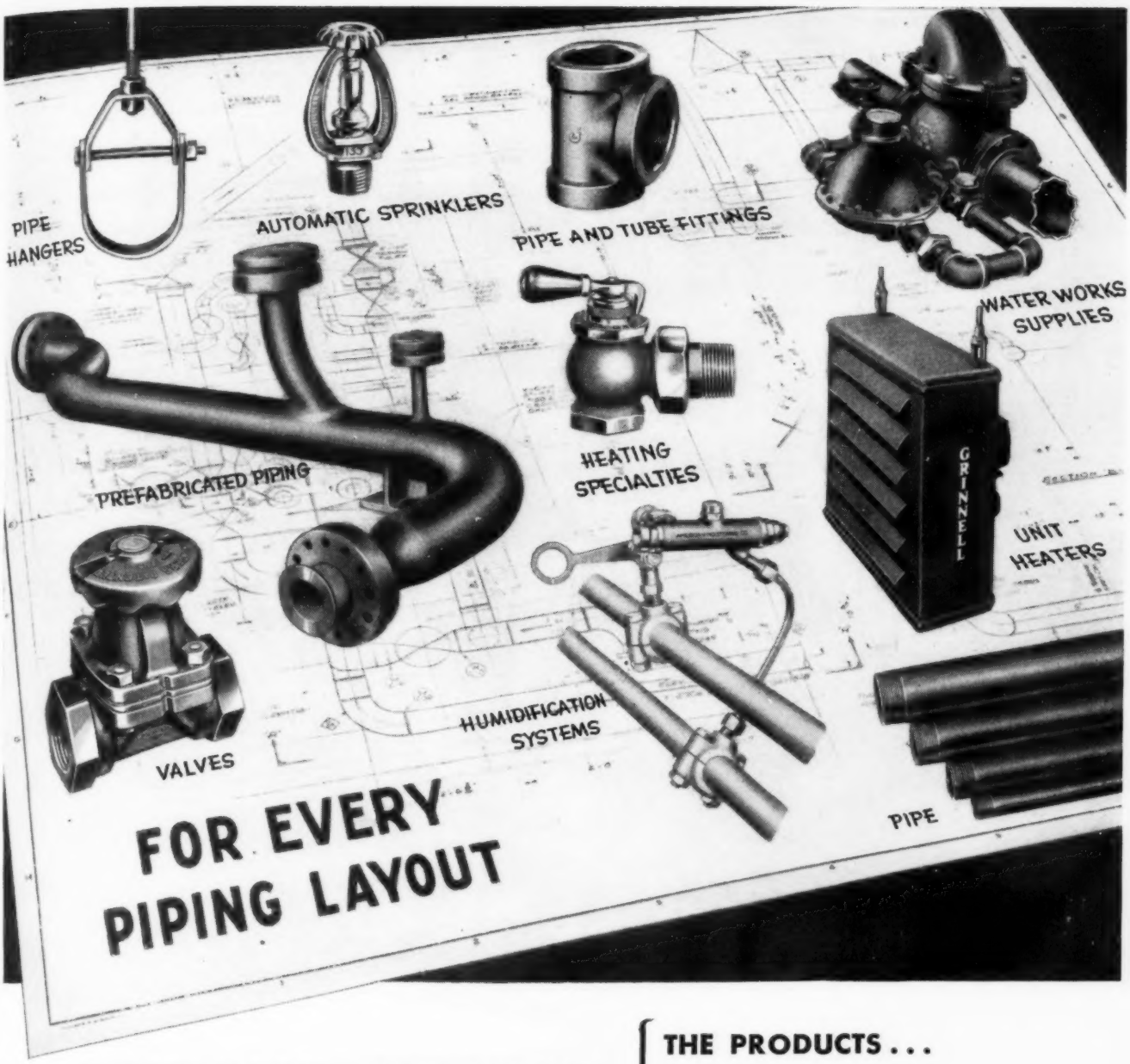
To the pulp and paper mills, tanneries, textile mills, chemical plants and many other industries, a low iron content is a necessity!

You have a specific iron and manganese removal problem! Permutit has the equipment! Permutit's equipment can remove iron by base-exchange, by aeration settling and filtration, or by oxidation through manganese zeolites.

Consult Permutit engineers without obligation! Write to The Permutit Company, Dept. W-10, 330 West 42nd Street, New York 18, N. Y., or to The Permutit Company of Canada, Ltd., Montreal.

Permutit

FOR 35 YEARS WATER CONDITIONING HEADQUARTERS



GRINNELL PROVIDES

THE PRODUCTS . . .
THE FACILITIES . . .
THE EXPERIENCE

Whether your piping layout involves installing simple water and air lines, protecting buildings from fire, supplying heat or humidification or transporting steam under 1,500 lbs. pressure, Grinnell provides the products, facilities and the experience for a *complete one-stop piping service.*

Grinnell manufactures a broad line of piping products and carries a complete stock of pipe, valves, fittings and piping specialties in strategically located branch warehouses . . . supplies prefabricated piping sub-assemblies ready to install . . . can help you engineer your piping system.

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Oakland 7, Cal.
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Sacramento 14, Cal.
St. Louis 10, Mo.
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San Francisco 7, Cal.
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Spokane 15, Wash.

GRINNELL COMPANY, INC.
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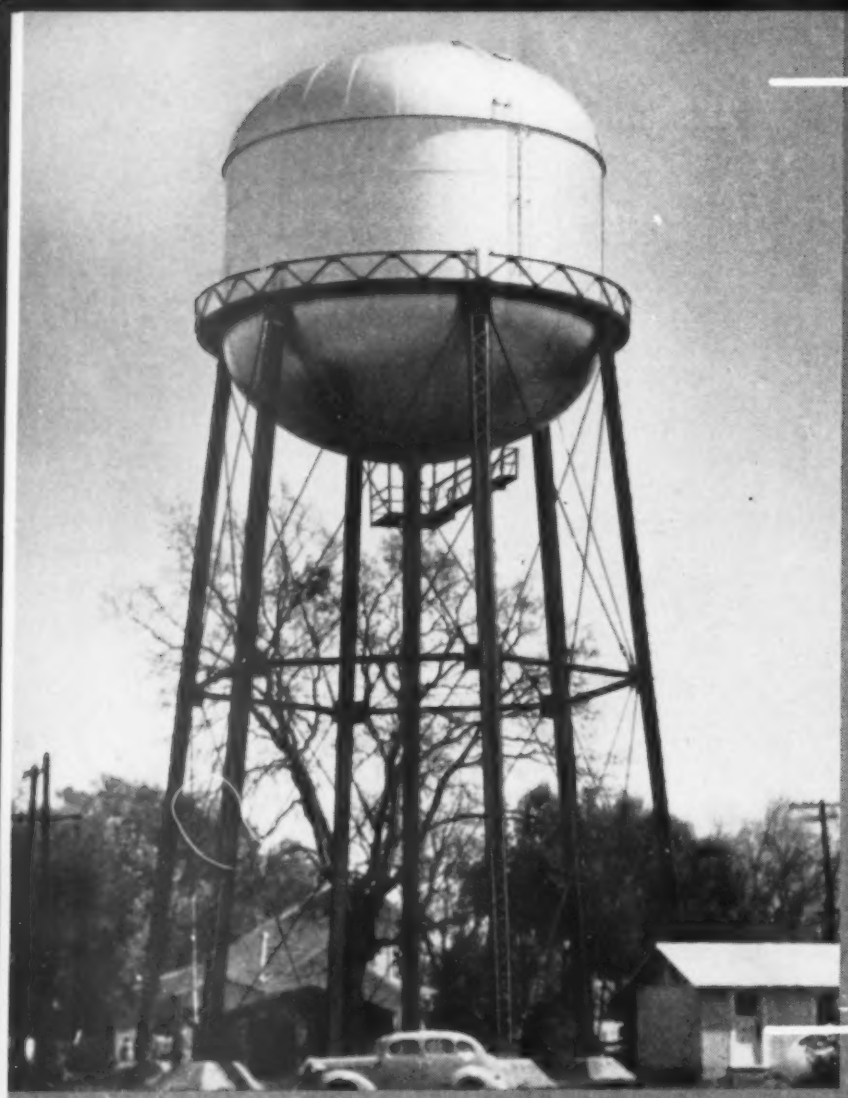

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GRIDLEY, CAL.
with
EFFICIENT
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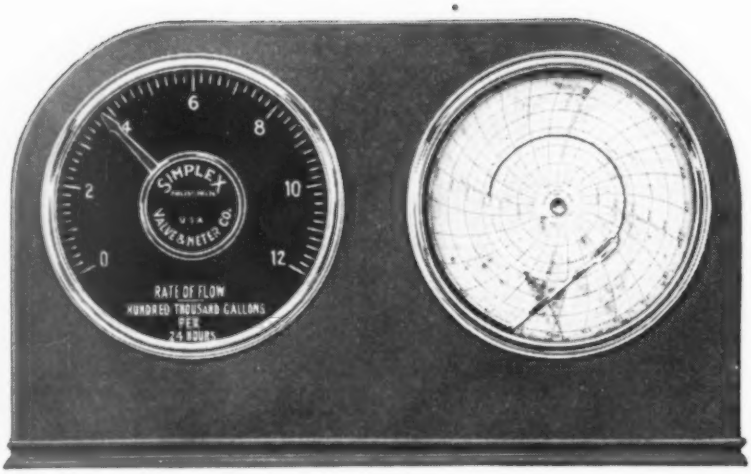
ACCURATE, DEPENDABLE



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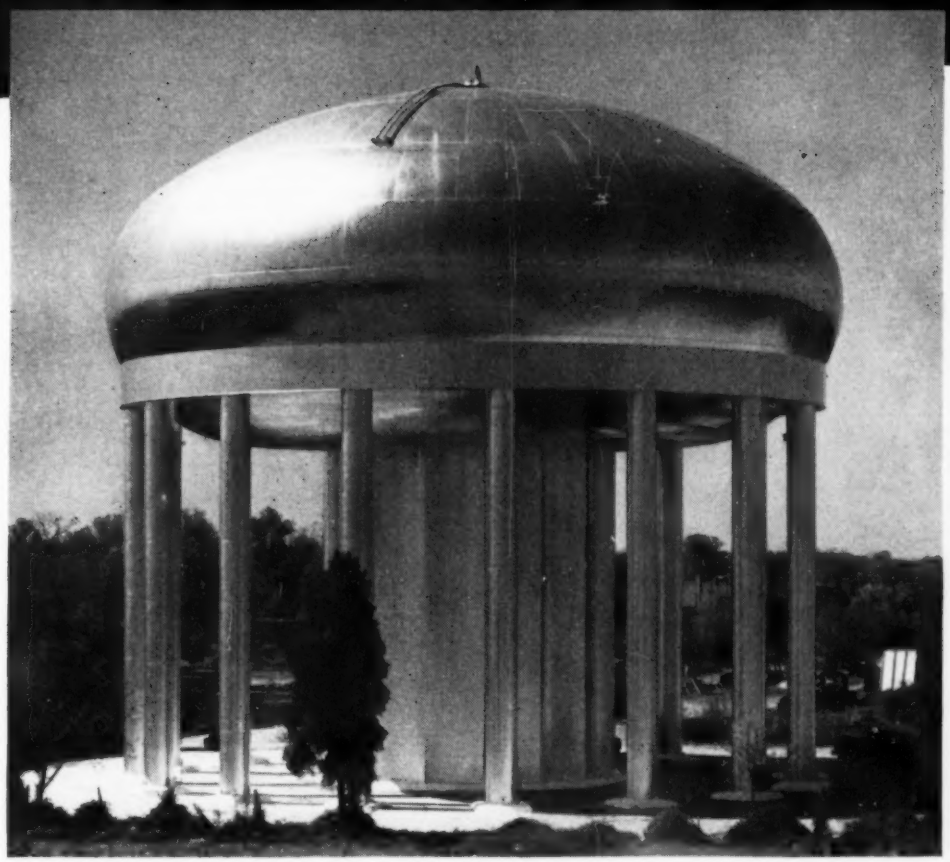

THE Horton spheroidal elevated water tank shown above provides a 2,000,000-gal. reserve in the Second High Service Area of the water system in Washington, D. C. The rapidly expanding population in that area had caused an increased demand and, during periods of peak consumption, it was drawing too heavily on the low service area from which it was receiving its supply.

The location and size of the tank made its architectural appearance an important consideration. When bids were taken for its installation, the specifications included a requirement that it be "as pleasing in appearance as possible." The design selected is a spheroidal tank supported on an outer ring of cylindrical columns and a central fluted column, a new construction feature in elevated tank design. The fluted central column serves primarily to support the center of the tank bottom, and does not contain water. Inside it is 5-ft. diam. riser which is connected to the mains. The tank has a range in head of 34 ft. 6 in. between the upper and lower water levels.

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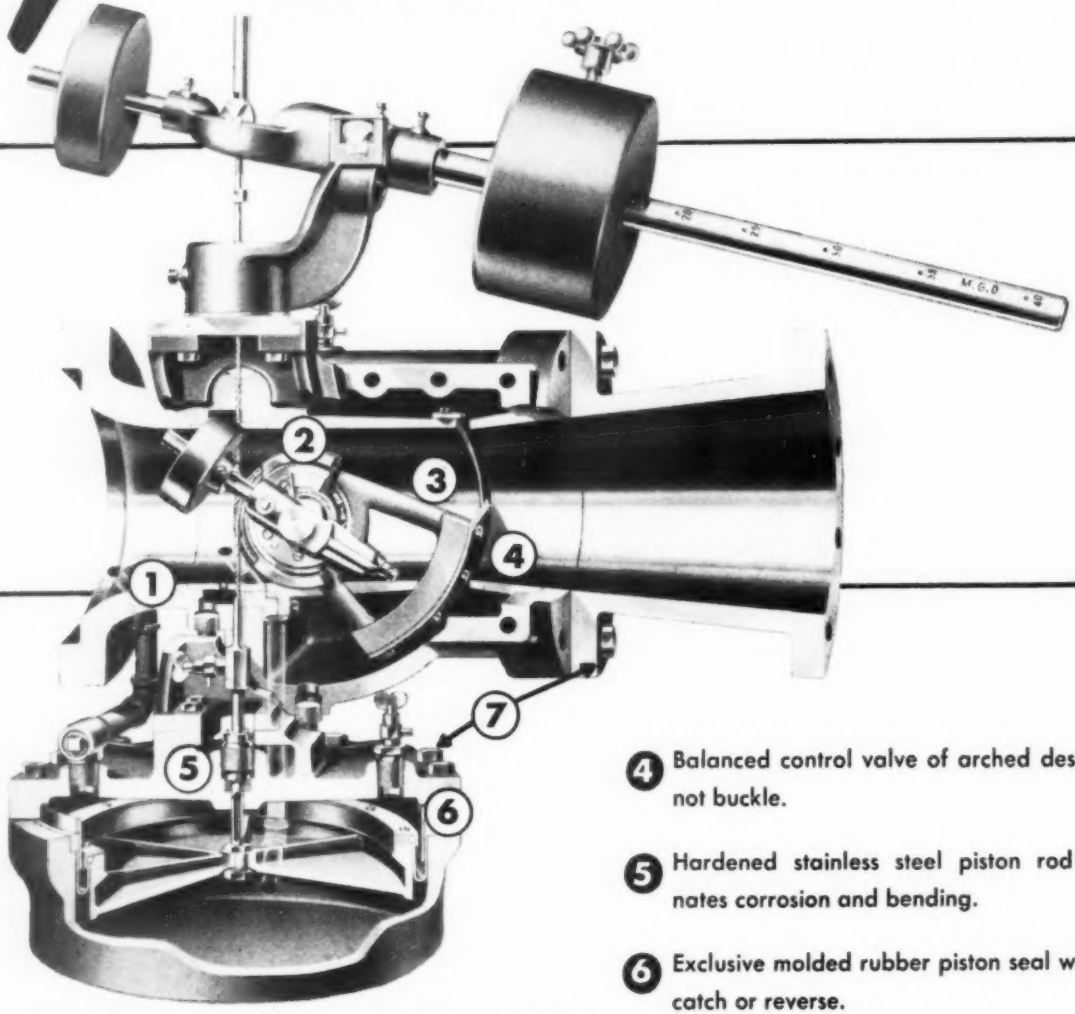

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(A Quick Quiz on modern pH advancements)

Do you know these important facts about BECKMAN pH CONTROL?

Do you know...

That Beckman pioneered modern glass electrode pH equipment?

Until Beckman pH instruments were developed, glass electrode pH equipment was a cumbersome, complicated laboratory curiosity. It was Beckman that pioneered today's simple, compact, highly accurate and completely dependable glass electrode pH equipment!

That Beckman pioneered virtually every major development in modern glass electrode pH equipment?

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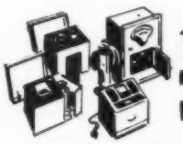

That Beckman offers the industry's most complete line of glass electrode pH instruments?

Included in the complete Beckman line are instruments specially designed to combine the high precision and wide versatility necessary for advanced research, medical and laboratory applications . . . others that combine maximum simplicity and high accuracy with complete portability for plant and field applications . . . still others that combine maximum simplicity and high accuracy with the plug-in convenience of full AC operation . . . plus *completely automatic* pH equipment for continuous pH indication, recording and control on large-scale processing applications.

That Beckman also provides the industry's most complete line of modern glass electrodes?

Although glass electrode pH instruments are the most efficient pH equipment obtainable, no glass electrode pH instrument is better than the versatility, accuracy and dependability of the electrode assemblies available for use with it.

Beckman provides the industry's most complete line of glass electrodes for use with Beckman pH instruments—a type of electrode assembly to meet every industrial, research, laboratory and field requirement!

That there are so many money-saving applications for Beckman pH control that you may be losing important profits unless you make a complete investigation of your operations?

There is pH wherever there's water, water solutions, moist pastes, sludges, slurries or other moisture-containing substances. And wherever there is pH, chances are the operation can be done better . . . with greater uniformity and less waste at lower overall cost . . . by Beckman-controlling the pH of the various processing operations.

SEE OUR EXHIBIT
CHICAGO COLISEUM
NATIONAL CHEMICAL EXPOSITION
OCT. 12, 13, 14, 15, 16 1948

WHETHER you manufacture food products or treat sewage . . . do metal plating or refine crude oil . . . make textiles or process ore — in fact, no matter WHAT *your field of operation . . . if you have not yet determined whether Beckman pH Control can be used to advantage in your operations — possibly is already* BEING *used to cut costs by your competitors — let us study your processes and make helpful recommendations. No obligation, of course.* BECKMAN INSTRUMENTS, NATIONAL TECHNICAL LABORATORIES, SOUTH PASADENA, 20 CALIFORNIA.

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For an informative, non-technical outline of modern pH control — what it is and how it's used — send for this free booklet "What Every Executive Should Know About pH."

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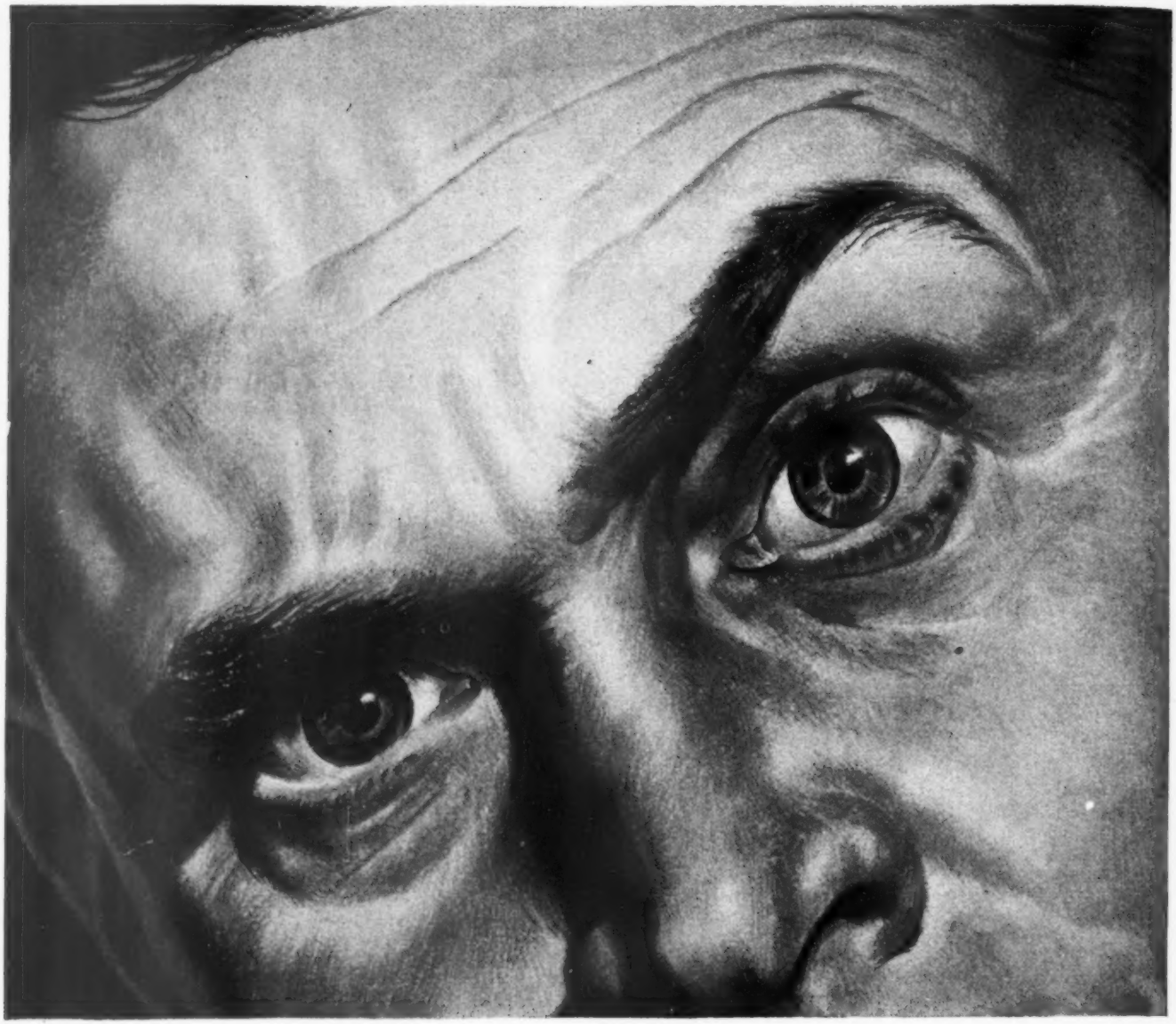


To the RAISED EYEBROW DEPARTMENT of your city

THIS IS ADDRESSED TO YOU, gentlemen. To the sanitation department of every city that once looked upon the General Electric Disposall* unit with alarm—yes, even with disapproval.

Believe us, we welcomed that look—that skeptical, "show me" attitude.

We realized from the beginning that any device as revolutionary as the Disposall method of garbage elimination would and *should* receive a questioning look from every sanitation official.

That's why years of development and testing went into the Disposall before it was presented to you. That's why we made sure—all along the line—that there was no danger of sewer stoppages or of any of the problems which might affect the normalcy of sewage-works operation. Only then were we ready to show you how practical, economical, and efficient this method was.

We believe that we have convinced sanitation officials almost everywhere as to the merits of the Disposall. Cities large and small have accepted this clean, sanitary, healthful method of garbage elimination—where necessary, revising sanitation codes to permit the use of Disposalls.

No, this is not the time to lower your eyebrows, gen-

tlemen—nor to close your eyes. Rather, it is a time to examine closely the qualifications of every food-waste shredder that makes its bid for acceptance. Are they, too, capable of matching *performance* with *promise?*

To assist you in judging that performance, the General Electric Company offers you its own list of specifications, as a guide in the development and perfection of the Disposall. This is indeed a strict list, gentlemen—but then the cleanliness, health, and efficiency of your community demands that any appliance which would serve that community be reliable in every respect.

We trust that our own experience in evolving a practical method of garbage elimination will be of value to you in ridding your community of the nuisance and menace that is garbage.

• • •

GENERAL ELECTRIC'S SPECIFICATIONS FOR ITS FOOD-WASTE SHREDDER—THE DISPOSALL

1. *The food-waste shredder should have a flow interlock that permits operation with cold water only.*

This is because experience has shown that only with cold water will greases become congealed within the cylinder. With congealed grease broken up into small particles, mixed with the food waste and carried off through the drain, there can be little tendency for greases to adhere to the walls of the pipe.

2. *The discharge from a food-waste shredder should always remain in a fluid state. The correct relationship between the amount of food waste and tap water should be maintained by controlled shredding.*

This permits the ready flow of effluent through traps, drain, or soil lines in a manner to prevent clogging.

3. *The food-waste shredder should shred food waste to a uniform size, to meet the following requirements: 100% shall pass a 4-inch screen. At least 90% shall pass a ¼-inch screen. Not more than 5% shall pass a #40 sieve.*

(Screens should be the United States standard, and weight should be taken on a dry basis.)

In other words, the particles of shredded food waste must be the correct size to permit effective sewage clarification and sludge digestion at the treatment plant.

4. *The food-waste shredder should be self-scouring, with no fouling surfaces.*

This prevents objectionable odors; keeps the unit clean as a whistle.

5. *The food-waste shredder should be free from electrical or mechanical hazards.*

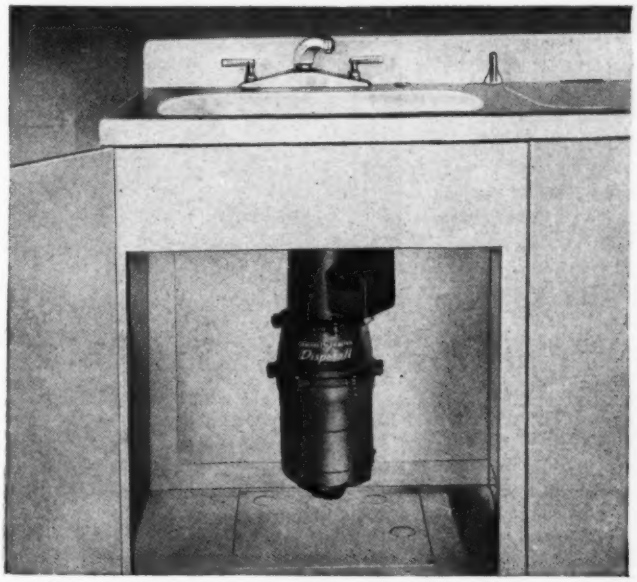
To be completely safe, the shredding compartment should be inaccessible during operation.

6. *The food-waste shredder should be permanently connected to the drain, and should be free from any cross-connection in accordance with the local plumbing code.*

This regulation eliminates any makeshift, homemade hookups, and permits the proper operation from sink to sewage treatment plant.

• • •

For further information about the Disposall method simply write Department WSW4810, General Electric Company, Bridgeport 2, Connecticut.



The General Electric Disposall is easily installed in almost any sink. Here it is shown installed in our Electric Sink. Food waste is scraped into drain opening and safety cover is placed in position. The cold-water tap is then turned on, starting the Disposall operation. Food waste is shredded and flushed away automatically.

P. S.—Thousands of Disposalls are operating successfully on private septic tank systems.

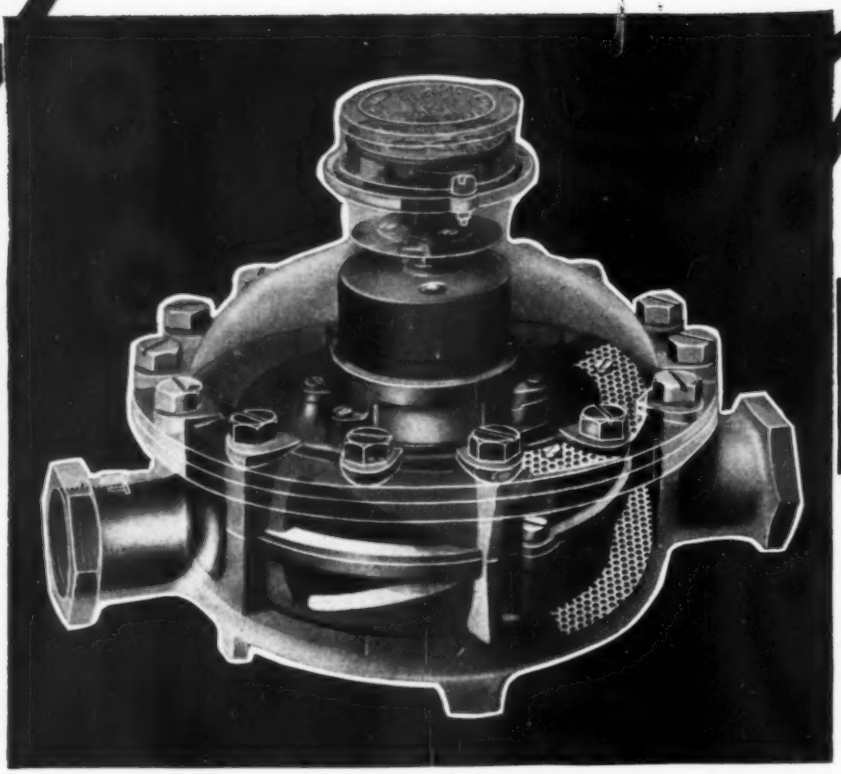
Disposall

*General Electric's registered trade-mark for its food-waste disposal appliance.

CONVERTS FOOD WASTE TO SEWAGE—ELIMINATES "GARBAGE"

GENERAL ELECTRIC

Accuracy



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WATER & SEWAGE WORKS

VOL. 95. NO. 10 OCTOBER. 1948

A Gillette Publication

SELLING SEWER RENTAL TO INDUSTRY

Experiences and Lessons Learned at Belleville, Illinois

by
GEORGE S. RUSSELL*
President F.S.W.A.
ST. LOUIS, MO.

THE existing sewage treatment plant in Belleville, Ill., was completed in 1939. The plant is of the separate sludge digestion activated sludge type. It is thought that this plant was originally designed to serve 40,000 people, but due to lack of funds, the aerator capacity was reduced one fourth. The plant is now overloaded, particularly in the secondary processes, due to the fact that there is a large industrial load which was not planned for in the original design. The average dry weather flow through the plant has been 3.74 mgd. with a maximum of 5.21 mgd. Although the flow is not excessive for the capacity provided, the average B.O.D. of this sewage has been about 400 ppm. Figuring 4.0 mgd. at 400 ppm., the equivalent population would be 78,400 people. As the aerator capacity was reduced to three fourths of the original design, we can easily see why the plant has become overloaded.

In order to eliminate pollution of the receiving stream and to provide for future growth, it has been decided to increase the capacity of the plant to 6.0 mgd., and a total B.O.D. loading of about 17,000 lbs. It has also been found necessary to make some additions and revisions to the sanitary sewers to take care of the growth of the city and the increased industrial loads. These improvements to the sanitary sewers and the additions to the sewage treatment plant will be financed by sewerage revenue bonds. In the development of a rate ordinance to support these sewerage revenue bonds, and in the discussions of this ordinance, we have encountered some interesting reactions which may be of value to others.

The Author

Developing an Ordinance and Rate Structure

In the past, for other communities, sewerage rate ordinances have been based on one of three methods.

The first method is to base the service charges, or sewer rentals, on volume alone. This has been accomplished by charging on the basis of the volume of water used where water is metered, or by employing a rate per fixture of different types which could be proportioned on water use.

The second method which has been used, bases the charge on strength alone. One basis for accomplishing this has been what is known as the "equivalent population" method. This method is usually predicated on the number of pounds of B.O.D. discharged to the sewer converted to equivalent population. In this computation the figure usually employed as representing the waste from one person is 0.17 lbs. of B.O.D. per day.

The third method represents a consolidation of the first two, basing the rental charge on a combination of volume and strength of sewage. The City of Akron has recently adopted such an ordinance. It seemed to the officials of Belleville that such a method was the logical one, and the engineers were instructed to develop such a rate structure, comparing the results obtained by this method, with payments to be made under other methods.

The cost of the improvements to be made at Belleville will be approximately $1,200,000. Of this amount, 60% can be charged to provisions to handle volumetric flow, and 40% as being chargeable to strength of the sewage, or B.O.D.

If the B.O.D. of *all* sewage, domestic and industrial, were approximately the same then the volumetric method could be used without any inconsistency. As the average B.O.D. of domestic sewage in Belleville was close to 200 ppm., it was decided to establish rates on the basis of the water used alone, as long as the B.O.D. of the sewage averaged not more than 200 ppm., and to make an additional charge for wastes which have a B.O.D. greater than 200 ppm.

* Russell & Axton, Engrs.

Using the figure of average domestic sewage strength at 200 ppm., and per cent of plant cost dependent on B.O.D. as 40%, it is apparent that the *additional* charge for B.O.D. in excess of 200 ppm., should be 40/200% or 1/5 of one per cent. It was also determined that in order to take care of operation and maintenance, and provide net earnings greater than 150% of that required for debt service, the sewer rental charge must be predicated on 60% of the existing water rates. These determinations produced the following proposed rate structure:

MONTHLY RATES

	Cu. Ft.	Rate Per 100 Cu. Ft.
First	13,000	$ 0.20
Next	13,000	0.15
Next	27,000	0.125
Next	27,000	0.096
Next	54,500	0.072
All Over	134,000	0.066

Additional charge—for every part per million of biochemical oxygen demand that the industrial waste exceeds 200, add one-fifth (1/5) of one per cent.

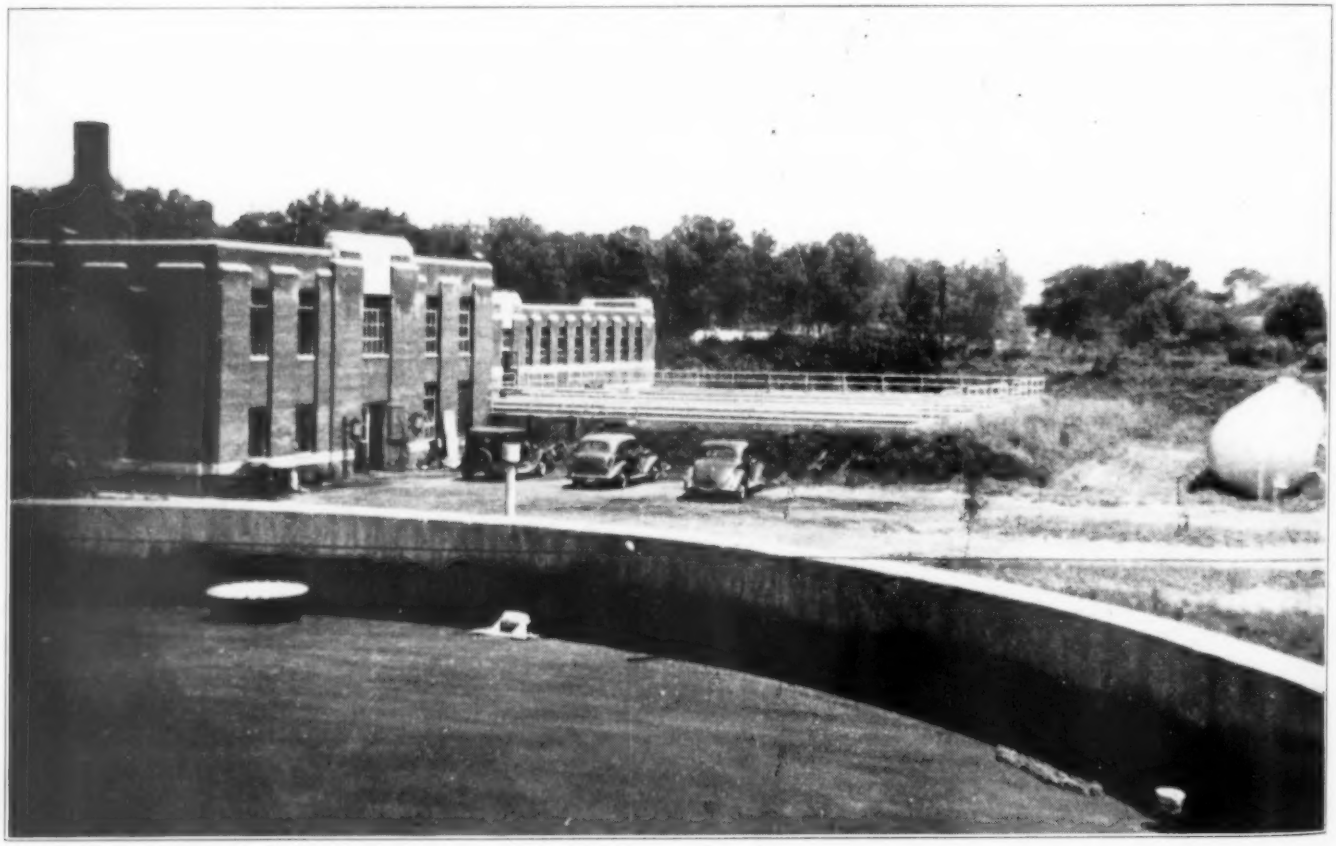
After it was determined that this rate structure would yield the required revenue, the city officials decided to hold a meeting with the larger industries in Belleville for the purpose of explaining the rate ordinance to them and, if possible, secure their endorsement of the program. It was at this point of the program that some difficulties were encountered. Discussions of B.O.D. and equivalent population seemed to leave the industrial representatives cold. They could not find anything wrong with the computations; neither could they get anything tangible out of them. These representatives all stated that they were satisfied if all industries could be put on the same basis, but they were all human enough to feel that their portion of the load was too high.

At this point, in the proceedings, it was decided to hold a joint meeting of the larger industries and to try to impress them with the fact that all computations were based on the same structure. At this meeting a large blackboard was provided and in the upper left hand corner the rate structure previously quoted was set out. Then this structure was used to compute the payments for each of the industries represented at the meeting. Complete data had been secured on the actual flow and the B.O.D. of each of these industrial wastes. The production of the industry during the period of the tests had also been secured. With the average daily flow and the B.O.D. for the particular industry it was easy to compute the average daily cost for each industry represented, and to show that these daily costs were predicated on the same rate structure. This information was, of course, nothing unusual in a study of this kind.

In making these computations, however, one additional step was taken. After the average cost per day was derived, the average production per day was computed. This allowed us to give to each industry the cost of sewer service per unit of their particular product. It was this specific form of information which seemed to be what the industries wanted. The meeting broke up with a general endorsement of the proposed sewerage rate ordinance by the industries represented.

How the Computations Were Conducted

In order to indicate how this work was done, and to give some figures which may be used as a comparison at other plants, we are setting out the computations for five of these



Present Industrially Overloaded Activated Sludge Plant of Belleville, Ill.

Enlarged plant to be financed through Sewer Service Charges based on rate schedule involving both volume and strength of domestic and industrial sewages.

industries; two breweries, one packing house, one canning factory, one laundry. We have included two breweries in order to show the effect of volume of production on the unit cost.

For ease of computation we shall first set out the rate structure on a daily basis.

DAILY BASIS

	Cu. Ft.	Rate Per 100 Cu. Ft.
First	433	$ 0.200
Next	433	0.150
Next	900	0.125
Next	900	0.096
Next	1,800	0.072
All Over	4,467	0.066

Additional charge — For each part per million of biochemical oxygen demand in excess of 200 ppm, add 1/5 of 1%.

Charges for Each Industry

Brewery No. 1

Average daily production 318.6 bbls.; sewage flow 0.1249 mgd.= 16,653 cu. ft./day; average B.O.D.= 724 ppm.

Rate on volume:

433	cu. ft.	@	20c	per 100	cu. ft.	= $0.8667
433	cu. ft.	@	15c	per 100	cu. ft.	= 0.6500
900	cu. ft.	@	12.5c	per 100	cu. ft.	= 1.1250
900	cu. ft.	@	9.6c	per 100	cu. ft.	= 0.8640
1800	cu. ft.	@	7.2c	per 100	cu. ft.	= 1.2960
12187	cu. ft.	@	6.6c	per 100	cu. ft.	= 8.0434
Total Cost for Volume per day						12.8451

Extra charge = 1/5 x (724-200) = 104.8%.

Additional charge = $12.84 x 1.048 = $13.46.

Total charge = $12.84 + $13.46 = $26.30 per day.

As this figure is based on producing 318.6 bbls. of beer, the cost per bbl. would be 26.30/318.6 = 8.3c per bbl.

Brewery No. 2

Average daily production 2730 bbls.; sewage flow 1.1 mgd. = 146,700 cu. ft./day; average B.O.D. = 690 ppm.

The total cost for volume, following method outlined for Brewery No. 1, is $98.68 per day.

Extra Charge = 1/5 x (690-200) = 98%.

Additional Charge = 98.68 x 0.98 =$96.81.

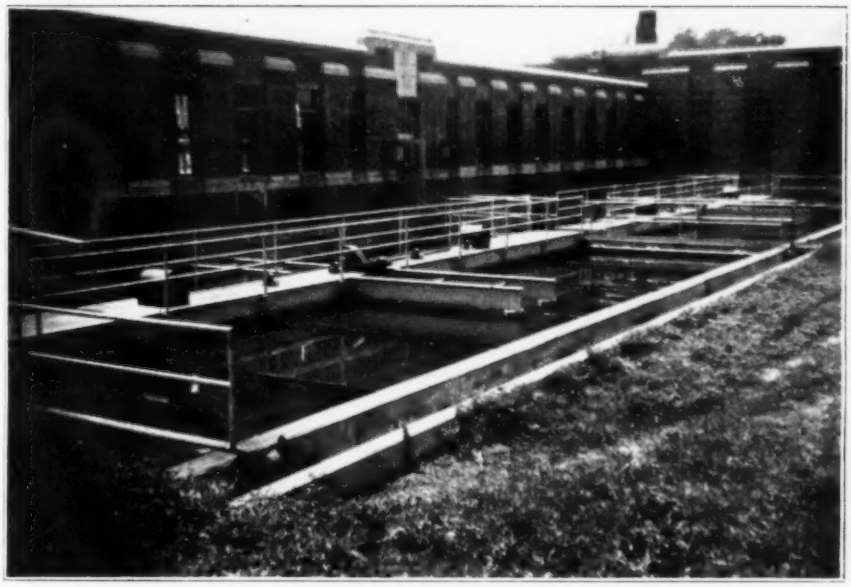
Total charge = $98.68 + $96.81 = $195.49 per day.

The cost per barrel of beer is 195.49/2730 = 7.2c per bbl.

This illustrates the reduction in unit cost with increased production.

Packing House

Total kill during test period of ten days, 130 cattle, 40 calves and 428 hogs, or an average hog equivalent of 98 per day. Sewage flow = .0147 mgd., or 1960 cu. ft.; average B.O.D. = 2451 ppm.



Rear View of Belleville's Activated Sludge Plant Showing the Clarifiers.

The total cost for volume computed from rate schedule is $2.83 per day.

Extra charge = 1/5 x (2451-200) = 450.2%.

Additional charge = 2.83 x 4.502 = $12.74.

Total charge = $2.83 + $12.74 = $15.57 per day.

The cost per hog equivalent is $15.57/98 = 16c per hog. This price can be materially reduced by better housekeeping and recovery, leading to the reduction in B.O.D. of the waste.

Laundry

Average sewage flow .0225 mgd. or 3,000 cu. ft./day; average B.O.D. of waste = 612 ppm.

The total cost for volume is computed as $3.75 per day.

Extra charge = 1/5 of (612-200) = 82.4%.

Additional charge = 3.75 x 0.824 = $3.09.

Total charge 3.75 + 3.09 = $6.84.

On the basis of 700 gallons of water per 100 lbs. of laundry, the average amount of laundry handled was 22500/7 = 3,200 lbs. of dry laundry. The cost per 100 lbs. of dry laundry would be 6.84/32 = 21c.

Canning Factory

Tests on this industry were confined to the bottling of catsup and the canning of spaghetti.

While bottling catsup, the average daily production was 3309 cases, the sewage flow average 0.0258 mgd., or 3440 cu. ft./day; the average B.O.D. = 1037 ppm.

The total cost for volume is computed as $4.06 per day.

The extra charge = 1/5 x (1037-200) = 167.4%.

The additional charge = 1.674 x 4.06 = $6.80.

The total charge 4.06 + 6.80 = $10.86.

On the basis of 3309 cases of catsup this amounts to ⅓ of a cent per case.

While canning spaghetti, the average daily production was 1445 cases; the sewage flow average 0.1216 mgd., or 16213 cu. ft./day; average B.O.D. = 398 ppm.

The total cost for volume is computed as $12.55 per day.

The extra charge = 1/5 x (398-200) = 39.6%.

The additional charge = .396 x 12.55 = $4.97.

The total charge is 12.55 + 4.97 = $17.52.

On the basis of 1445 cases of spaghetti, this amounts to 1.2 cents per case.

It seems that this reduction of sewage handling costs to a cost per unit of production gives the industry some tangible figure which they can use in revising their cost of production. This analysis is presented with the idea that in many instances in the past our inability to satisfy industry that our methods are sound has probably been due in a sense to our inability to "talk the same langauge."

FEDERATION PROGRAM FOR DETROIT MEETING

FINAL plans have been made and released for the program of the 21st annual meeting of the Federation of Sewage Works Assns., to be held in Detroit on Oct. 18-21, at the Hotel Statler.

In addition to the technical program which is given below, there are a number of functions of strictly social nature. Opening the social program on Monday evening, Oct. 18, there will be a Reception-Entertainment, beginning with an informal reception and ending with a 2-hour variety entertainment.

The Federation Annual Luncheon is scheduled for Tuesday noon, Oct. 19, and the feature of this luncheon will be an address, "Let's Be Realistic About Pollution" by Kenneth L. Reid, Exec. Secy., Izaak Walton League of America.

The Annual Federation Dinner and Dance is scheduled for Wednesday evening, Oct. 20. Some entertainment will be provided at the dinner, which will be followed by dancing. The only official business scheduled for the dinner is the presentation of the Federation's annual awards.

Ladies' Entertainment

Plans for ladies' entertainment include a luncheon at Greenfield Village, the beautiful historical exhibit of the Ford Motor Co. at Dearborn. The ladies will have a choice of a bridge party or a visit to the Ford gardens. Also planned are a sight-seeing tour of Detroit and adjacent points, and a visit to a radio or television broadcast. The program committee promises the ladies plenty of time for shopping, including any that may be done in Canada across the River.

During the 3½-day program, 30 manufacturers will exhibit their wares in 52 booths located in the exhibition hall of the hotel.

THE TECHNICAL PROGRAM

MONDAY, OCTOBER 18

Morning

Welcome to Detroit
Hon. Eugene I. Van Antwerp, Mayor, City of Detroit

Moving Picture—"Taken for Granted"
Compliments West Middlesex Main Drainage, London, England

Plans and Activities of the USPHS in Relation to Water Pollution Control Act
Carl E. Schwob, Dir. Water Poll. Control Sect., USPHS

Integration of Administration of Civilian Medical Care in Event of Total War
Col. W. L. Wilson, U. S. Army Medical Corps

Afternoon

USPHS Survey of the Detroit River
M. LeBosquet, Jr., Sanitary Engineer, USPHS

Sewage Treatment and Waste Disposal in Ontario
Dr. A. E. Berry, Dir. San. Eng. Div., Ont. Dept. Health

Problems of Waste Disposal from Atomic Energy Operations
Arthur E. Gorman, San. Engr., U. S. Atomic Energy Comm.

TUESDAY, OCTOBER 19

Morning

Mechanisms of Hydrogen Sulfide Production
Rolf Eliassen, Professor of Sanitary Eng., New York Univ.

A System of Bio-Precipitation of Organic Matter from Sewage
Daniel A. Okun, Teaching Fellow in San. Eng., Harvard Univ.
Discussion: Dr. F. W. Mohlman, Director of Laboratories, The Sanitary District of Chicago

Effects of Synthetic Detergents on Sewage Treatment Processes
Dr. Willem Rudolfs, Chief, Dept. of Sanitation, Rutgers Univ.

Mathematical Aspects of Bulking Activated Sludge
L. S. Kraus, Chemist, Peoria (Ill.) Sanitary District

Noon

The Annual Federation Luncheon
Address: **"Let's Be Realistic About Pollution,"** Kenneth L. Reid, Executive Secretary, Izaak Walton League of America

Afternoon

The Industrial Wastes Forum

Effluents from Chemical Manufacture at Bound Brook, N. J.
Dr. V. L. King, Technical Director, Calco Chemical Division, American Cyanamid Co.

Dairy Waste Disposal
E. F. Eldridge, Research Professor, Michigan State College

Indices of Stream Pollution
Don E. Bloodgood, Professor of San. Eng., Purdue Univ.

Wastes from Chemical Manufacture
R. W. Hess, Chemist, National Aniline Division, Allied Chemical and Dye Corporation

WEDNESDAY, OCTOBER 20

Morning

Factors Affecting Efficiency of Activated Sludge Sewage Treatment Plants
William E. Stanley, Professor of Sanitary Eng., M.I.T.

Biology of Sewage Treatment
James B. Lackey, Editor, Medical and Scientific Division, Blakiston Publishing Company

Sewer System Operation and Maintenance Practices at Milwaukee
Lloyd D. Knapp, Supt., Bureau of Sewers, Milwaukee.

Design and Operation of the Detroit Sewage Treatment Plant
Fred H. Burley and W. M. Wallace, respectively, Engineer of Sewage Treatment and Superintendent of Filtration and Sewage Treatment, City of Detroit

Afternoon

Inspection Trip
Detroit Sewage Treatment Plant
Dearborn Sewage Treatment Plant

THURSDAY, OCTOBER 21

Morning

The Operators' Forum
Ralph L. Fuhrman, Leader

Annual Operation Reports
Corrosion Problems
Mechanical and Electrical Maintenance
Public Relations
Paints and Protective Coatings
Sewer Ordinances

Noon

Adjournment

SLUDGE PUMPING THROUGH LONG FORCE MAINS

Experiences and Cost Data During 10 Years of Operation of the 13 Mile Long 12-Inch Sludge Force Main of Cleveland, Ohio

by

JOHN J. WIRTS*

Asst. to the Commissioner
DIV. OF UTILITIES ENGINEERING
DEPT. OF PUBLIC UTILITIES
CLEVELAND, OHIO

THE transporting of sewage solids (sludges) over long distances by pumping through force mains is occasionally used for the solution of certain sewage treatment problems. Especially in the larger cities it is sometimes economical to process sewage sludge at a point remote from the treatment plant developing the sludge. Usually the location, space limitations, land values and foundation conditions at the treatment works site are the limiting factors that warrant the pumping of sludge several miles to a better suited area. Cleveland, Chicago and Mogden, Eng., have for many years processed sludge at sites widely separated from the particular treatment works which produced the sludge.

The Author

The Mogden Works at Middlesex, England, is located in a residential district similar to that of the Easterly Works at Cleveland and also to that of the North Side Treatment Plant at Chicago. In each case the area is well developed, with residences quite close to the treatment plant.

The Mogden Works is an activated sludge plant with an average flow of 85 mgd. Mixed primary and excess

*Formerly Superintendent, Easterly Treatment Works.

Fig. 1. Easterly Treatment Works in Cleveland's "Front Yard"

From which all primary and excess activated sludge is pumped 13 miles through a 12 inch cast-iron force main to Cleveland's Southerly Plant for digestion and dewatering.

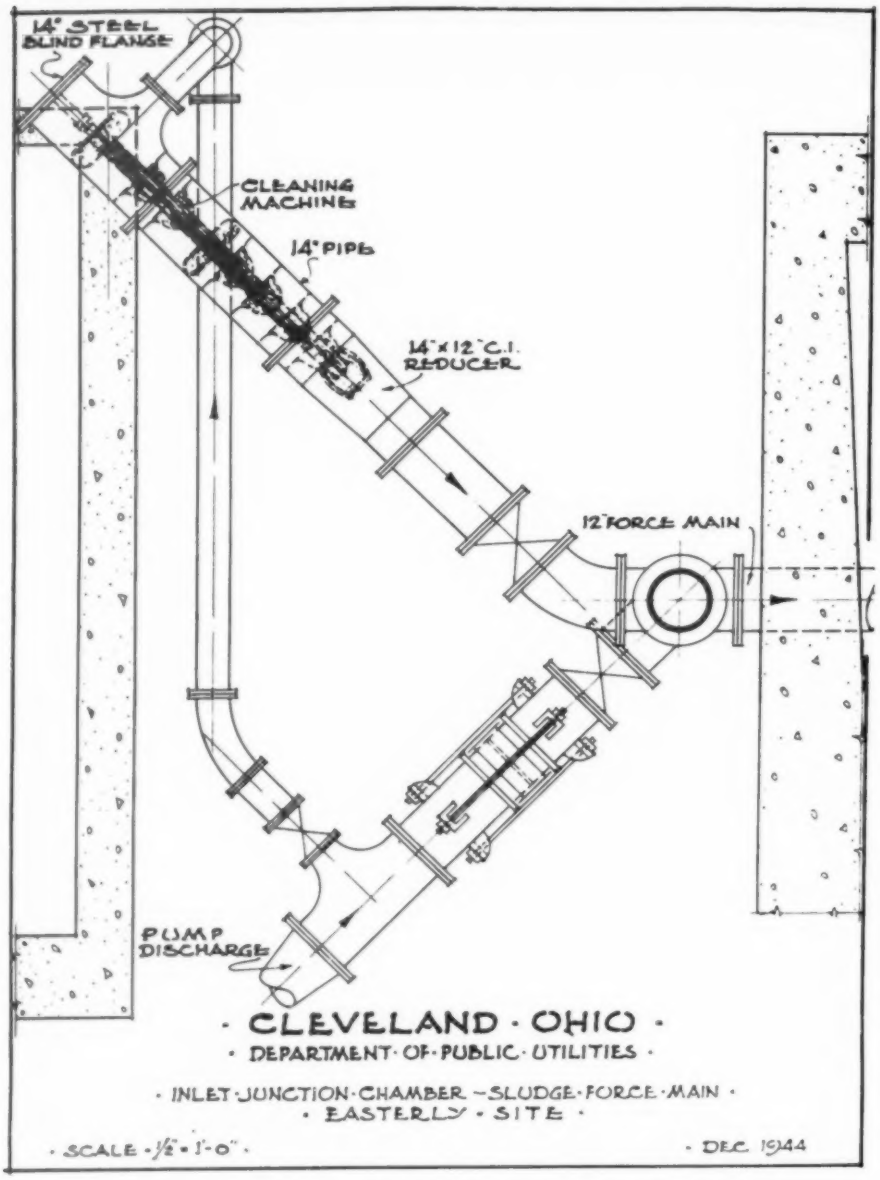

14" STEEL BLIND FLANGE
CLEANING MACHINE
14" PIPE
14"x12" C.I. REDUCER
12" FORCE MAIN
PUMP DISCHARGE
· CLEVELAND · OHIO ·
· DEPARTMENT · OF · PUBLIC · UTILITIES ·
· INLET · JUNCTION · CHAMBER — SLUDGE · FORCE · MAIN ·
· EASTERLY · SITE ·
· SCALE · ½" = 1'-0" ·
· DEC. 1944

Fig. 2. Inlet Junction Chamber at the Easterly Plant

With main cleaning machine inserted through the 14 in. T, and blind flange bolted back in place, the 12 in. inlet valve is opened. Thereafter, the bypass line from the pump discharge line to the insertion chamber is opened to force the machine or "go-devil" into the 12 in. main. Once past the insertion valve, this valve is closed and the main pump discharge valve is opened sufficiently to force the "go-devil" over the 13 mile journey to the Southerly Plant at the rate of travel desired.

activated sludge are reduced by partial digestion at these works to 60 per cent volatile matter. This sludge is then pumped through 12-inch cast iron force mains (constructed in duplicate) to the Sludge Processing Works at Perry Oaks, some seven miles distant.

The Mogden pumps are two-cylinder horizontal double acting piston pumps, electrically driven and capable of delivering a maximum of 800 gallons of sludge per minute against a head of 150 feet. The usual pumping rate is 660 gpm. resulting in a velocity of 1.87 fps. in the force main. The total pressure in the pumps is only 65 pounds per square inch or 142 feet of head, made up of 65 feet of static lift and 77 feet of friction loss. Thus, the total friction head is 11 feet per mile or 1.4 times that which would be experienced if pumping water. It is reported that this loss has not altered during eleven years of sludge pumping, except for a definite inclination to be higher during the first months of operation in 1936 when the sludge was not sufficiently digested. The water content of the digested sludge is about 95 per cent.

A 14-inch cast iron force main approximately 17 miles long connects the Chicago North Side activated sludge plant with the Chicago Southwest Works. Excess activated sludge, and at times primary sludge, is pumped at 95 pounds pressure to the sludge processing units of the Southwest Works. Three horizontal, motor-driven, single-suction, centrifugal pumps, each with a capacity of 2 mgd. when pumping against a total head of 180 feet, are provided for pumping the waste sludge. The relatively dilute undigested sludge, containing 99 per cent water, has been successfully pumped a number of years without any particular difficulty.

Cleveland's Sludge Force Main

In 1931, the late George B. Gascoigne[1], consulting engineer, of Cleveland, recommended in his "Report Upon the Easterly Sewage Treatment Plants of Cleveland, Ohio," that a 12-inch force main, having a sludge transfer capacity of 1.5 mgd, be installed leading to the Southerly site. The Gascoigne plan was adopted and in 1938 the 12-inch sludge force water main 13 miles long was put into service. At that time there was very little information available, except from the Chicago experience, as to pressures required and loss of coefficient due to force main clogging, or deposits on the pipe walls; consequently no means were provided for cleaning the main without discontinuing the pumping of sludge for a long period of time.

In an emergency, the Easterly Activated Sludge Plant can without undue hardship store excess sludge for a period of 48 to 72 hours. Beyond that period it becomes necessary to pump raw sludge into Lake Erie, which is not good practice. Therefore, except for short periods the force main must be available at all times to transport the peak sludge load, otherwise the 10 million dollar Easterly Plant becomes ineffective.

CLEVELAND'S OPERATING EXPERIENCES

During the first or tuneup period (1938-1939), the waste sludge contained 2.0 per cent dry solids and was pumped as produced without further concentration. No particular difficulty was experienced during this period. Beginning in January 1940, excess activated sludge was concentrated in the primary settling tanks which increased the solids content of the waste sludge to 3.0 per cent, for the period 1940 to 1941. The purpose of increasing the solids content of the sludge was to relieve the digestion units at the Southerly

site of the necessity for handling excessive water, thereby decreasing the digester detention time or increasing design requirements, while also reducing digester temperatures.

Almost immediately it was observed that 3.0 per cent solids caused an increase in pumping pressure, and at times the rate of pumping dropped to 0.4 mgd. Segments of the force main were removed at several locations and while the sides of the pipe were fairly clean, fine grit was found on the bottom, and considerable grease, hair and match sticks hung from the top. The segment at point of greatest pressure contained more deposit than other segments. Repeated flushing with settled sewage using all available pumps for periods of 9 to 10 hours did not materially clean the force main. It was apparent that the pumping of 3.0 per cent solids, as anticipated in the design, could not be continued without some method of readily and economically removing the surface deposits inside the force main.

As a temporary measure, a contract in the amount of $5,000.00 plus labor, was let for cleaning the sludge line during January 1941. This cleaning raised the coefficient "C" in the Hazen and Williams pipe line capacity formula from 80 to greater than 130. Again in November 1942 the force main was cleaned by contract at a cost of $1,250.00 plus labor. During the interval between the first and second cleanings there was a steady increase in pump discharge pressure even though the solids content of the sludge was reduced 2.5 per cent for the year 1942. The restoration of capacity and efficiency resulting from the 1942 cleaning was of the same order as that obtained by the January 1941 cleaning.

Each of the two contract cleanings required the force main to be out of service for the greater part of a week, thus considerably handicapping the Easterly Works. In addition a two months' period of time was needed for legal procedure before actual execution of a competitive contract could proceed. It became quite evident from these conditions, even overlooking the cost, that a routine cleaning operation had to be established if the digestion tanks at the Southerly site were to operate as designed and force main to be kept in continuous service.

Junction Chambers Constructed

Junction chambers, as here understood, are simple piping arrangements used by common carriers of the oil industry for rapid insertion and removal of cleaning tools from force mains without disconnecting the main from service. Through the courtesy of Mr. E. F. Morrill, Chief Engineer, Sohio Petroleum Co., St. Louis, Mo., data on viscosity and junction chamber drawings were made available to the writer. Based on this information the inlet junction chamber at the Easterly or inlet end of the force main was designed as shown in Fig. 2. The 14 inch section of pipe connected to the 14 x 12 inch reducer provides a means of sliding the main cleaning machine into place without the use of jacks or pressure of any kind. The valving arrangement allows the machine to enter the 12 inch section of the force main without taking the main from service. Similarly Fig. 3 shows the outlet junction chamber arrangement at the Southerly Plant that permits the cleaning machine to be removed after traveling the 71,000 feet from plant to plant.

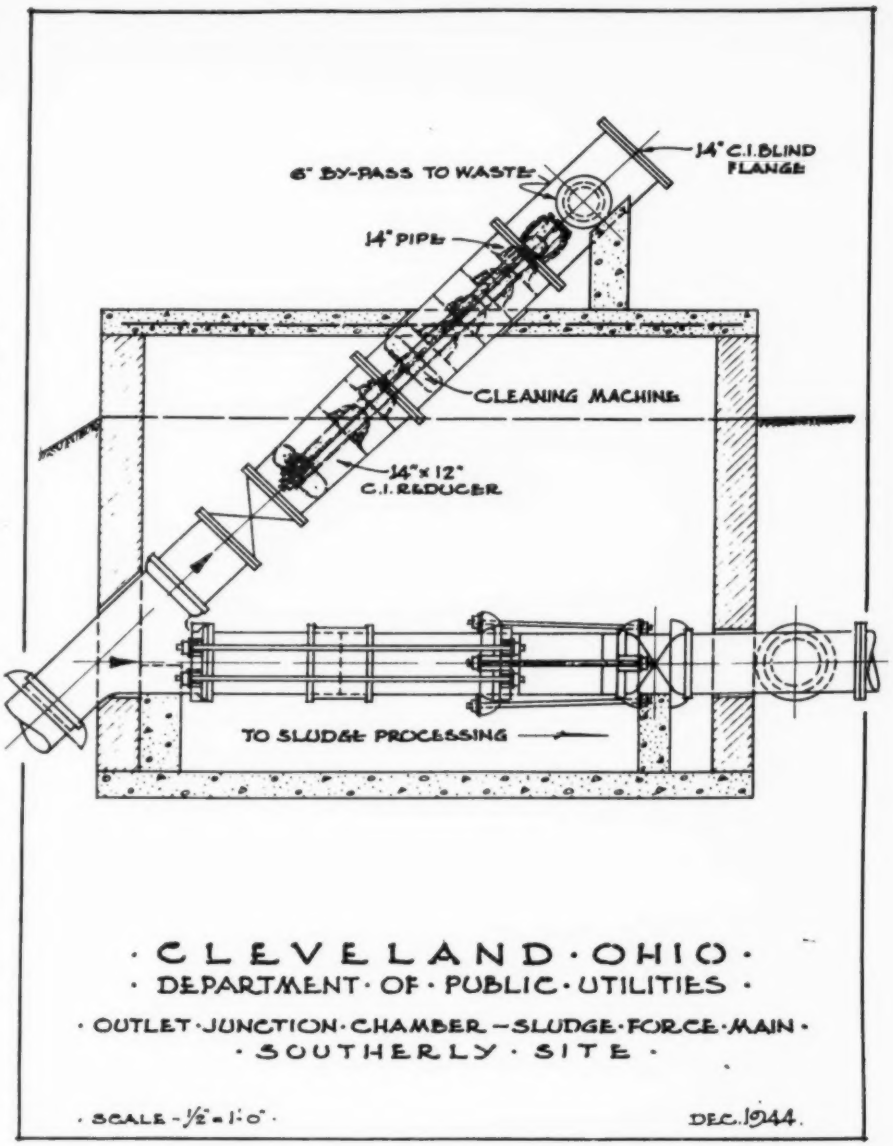

6" BY-PASS TO WASTE
14" C.I. BLIND FLANGE
14" PIPE
CLEANING MACHINE
14" x 12" C.I. REDUCER
TO SLUDGE PROCESSING
· CLEVELAND · OHIO ·
· DEPARTMENT · OF · PUBLIC · UTILITIES ·
· OUTLET · JUNCTION · CHAMBER — SLUDGE · FORCE · MAIN ·
· SOUTHERLY · SITE ·
· SCALE - ½" = 1:0" ·
DEC. 1944.

Fig. 3. Outlet Junction Chamber at the Southerly Plant

With the valve on the main line to the digesters closed, and the 6 in. bypass from the 14 in. withdrawal chamber open, the "go-devil" is trapped when it reaches the Outlet Junction Chamber. With the withdrawal chamber valved off, and the main line valve opened, the blind flange is removed from the trap and the "go-devil" withdrawn for overland return to the Easterly Plant.

Prior to the construction of these chambers the action of the cleaning machine was established by a test piping set-up, where pressure and volume measurement were determined. The tests were felt necessary to clear up all doubt as to the feasibility of the junction chambers.

The junction chambers were completed and ready for service by August 1, 1944.

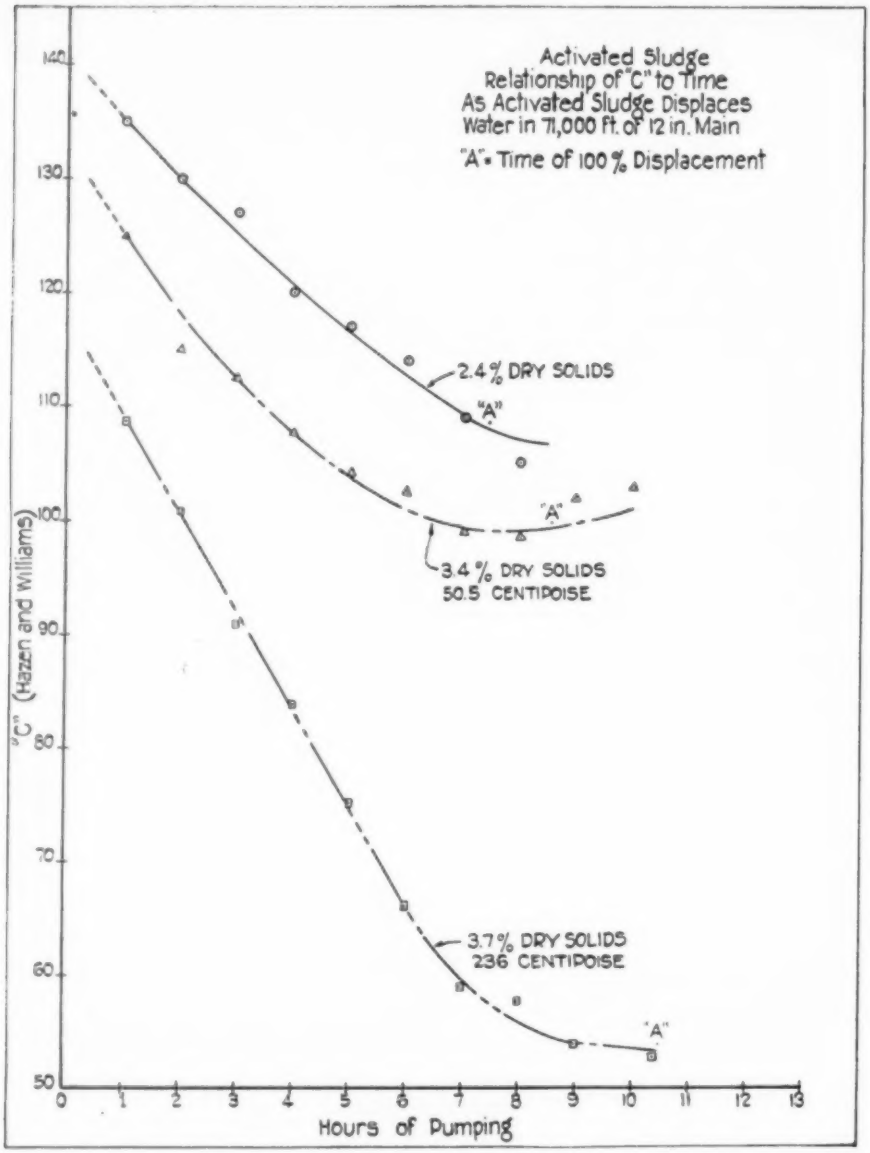


Fig. 4. Curves Revealing the Effects of Sludge Density and Viscosity on the "C" Value of the Hazen & Williams Flow Formula

The relation between sludge density or viscosity and pumping time for a given delivery is clearly revealed.

Test Data— Before and After Cleaning

Since August 1, 1944, it has been possible usually to clean the entire 71,000 feet of 12 in. main in 8 hours, as a matter of routine operation. Occasionally, however, the machine has been held up during its travel, due to excessive deposits or improper adjustment of the machine. It is important therefore that records be carefully kept and used as a guide to determine the frequency of cleaning. Table I indicates the reduced pressure and increased capacity which results from cleaning.

Quantity and Cost of Sludge Pumping

Prior to 1944 the waste sludge pumps were in operation about 98 per cent of the time. Maintenance of equipment and force main required about 2 per cent of the time. Since the installation of the two terminal junction chambers it has been routine to pump sludge during only 10 hours each day, which is only 42 per cent of the available time. Clogging due to pump stoppage has been completely eliminated. The effect of reduced operation time is indicated in Table II by reduction in volume of sludge pumped and corresponding increase in per cent dry solids contained in the sludge. The pump operation is now covered by two shifts of 8 hours each instead of full 24 hour coverage. During the past four years the 3.0 per cent dry solids design requirement has been considerably bettered by actual pumpage of 3.3 to 3.8 per cent dry solids. The effect on digestion capacity at the Southerly site is quite apparent.

Table III presents the total expenditure in connection with the operation and maintenance of the sludge pumps and force main. During the period of 8 years (1940 to 1947) covered by these data, operation labor in some cases has increased ninety per cent. Replacement parts have increased approximately 40 per cent. An overall increase in cost of 30 per cent has been more than offset by the technical improvement to the process and by the standardization of pumping equipment. The cost of a single complete cleaning of the entire main has been reduced to around $75.00 depending upon the time required.

It is interesting to point out that the cost of pumping one ton of dry solids 71,000 feet (Table II), when the solids are contained in a mixture of 96 per cent water, is about one half of the cost of shoveling one ton of grit 20 feet. This example indicates the advantage of utilizing mechanical equipment over certain manual operations still being performed even in some of the larger plants.

In order to produce a yearly average of 3.8 per cent dry solids in the waste sludge, it is necessary at times to pump sludge of 4 to 5 per cent solids or even higher. Since digestion capacity is of prime importance in the treatment system, expenditures for improved pumping of concentrated solids can be easily justified. The data presented has shown that 3.8 per cent solids can be handled at less cost than more dilute sludge. There would appear to be no physi-

Table I

TYPICAL TESTS BEFORE AND AFTER CLEANING

Date	Pumping Rates Mgd.		Pressures Lbs./Sq. In.		Machine Speed Ft./Sec.
	Before	*After*	*Before*	*After*	
8- 1-44	0.60	1.33	166	132	——
8-16-44	0.64	1.68	170	137	1.47
9-13-44	1.10	1.35	174	165	1.26
11-15-44	1.07	1.26	165	155	2.34
7-24-45	1.09	1.25	172	145	**
9-18-45	0.61	1.41	188	155	1.80
10- 9-45	0.78	1.56	177	149	2.22
10-24-45	1.03	1.50	160	139	2.63
6-10-46	1.17	1.56	160	142	2.14
11-19-46	1.40	1.43	152	148	2.64
7-15-46	1.20	1.36	164	156	2.66
10-14-47	0.81	1.12	170	157	*

*Machine held up due to excessive deposits. **Partial cleaning about 5 miles.

cal reasons why, with slight modification, the existing equipment at Cleveland could not be redesigned to pump 5 per cent solids. The pump operator should be concerned only with the mechanical performance of equipment capable for transporting the highest possible concentrations of sludge. His anxiety over excessive pressure and possible failures could be relieved.

Viscosity of Activated Sludge

Sewage sludge does not constitute a homogeneous fluid, and the more common fluid flow laws can be applied only approximately. The character of sludge varies from time to time as to its moisture content and condition of the solids. One of the important elements in the study of sludge flows is that of viscosity. Two essential requirements for field viscosity measurements are a pipe line of known degree of roughness and an adequate and uniform supply of the fluid to be tested. With the storage of activated sludge in a final settling tank, the Easterly Plant had both essentials. The concentration of the activated sludge was controlled within comparatively narrow limits so that a series of viscosity tests could be run on several concentrations of activated sludge.

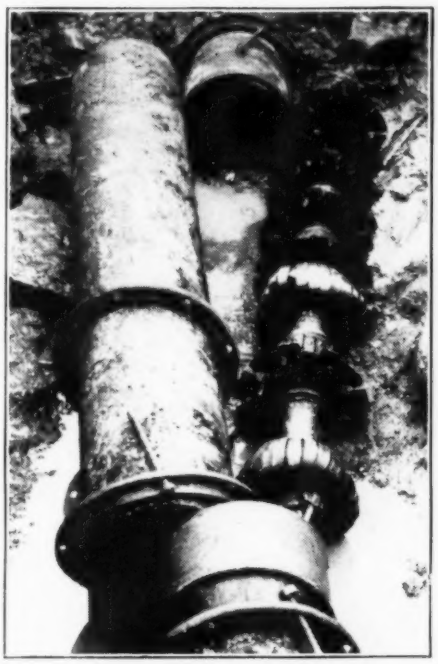


Fig. 6. A Standard 12-in. National Main Cleaning Machine

An exact replica of the tool first rented and later purchased by Cleveland for routine cleaning of the sludge force main connecting the Easterly and Southerly plants. The machine travels in the direction in which it is pointed—away from the reader.

To demonstrate the relationship of "C" in the Hazen and Williams flow formula to activated sludge pumping, typical data are plotted in Fig. 4. The effect of displacing water with uniform activated sludge in the force main is shown by the very rapid drop-off of "C". Since "C" is a roughness coefficient and since the degree of roughness does not change during the test, this apparent increase of "C" value is of course untrue. Instead of roughness it is the viscosity of the fluid flowing that requires the additional energy. Viscosities computed from suitable formulae are given on the graphs. These are based on hourly dry solid analyses and are the average for the period of test. No attempt was made to measure the effect of viscosity on pump efficiency. Point "A" on the 3.7% curve (Fig. 4) is well inside the non-turbulent flow region for viscous fluids.

The Easterly Plant is well fitted to continue the viscosity studies on both the force main and the sludge pumps. For the present it is probably sufficient to compute sludge force main losses in terms of 1.5 to

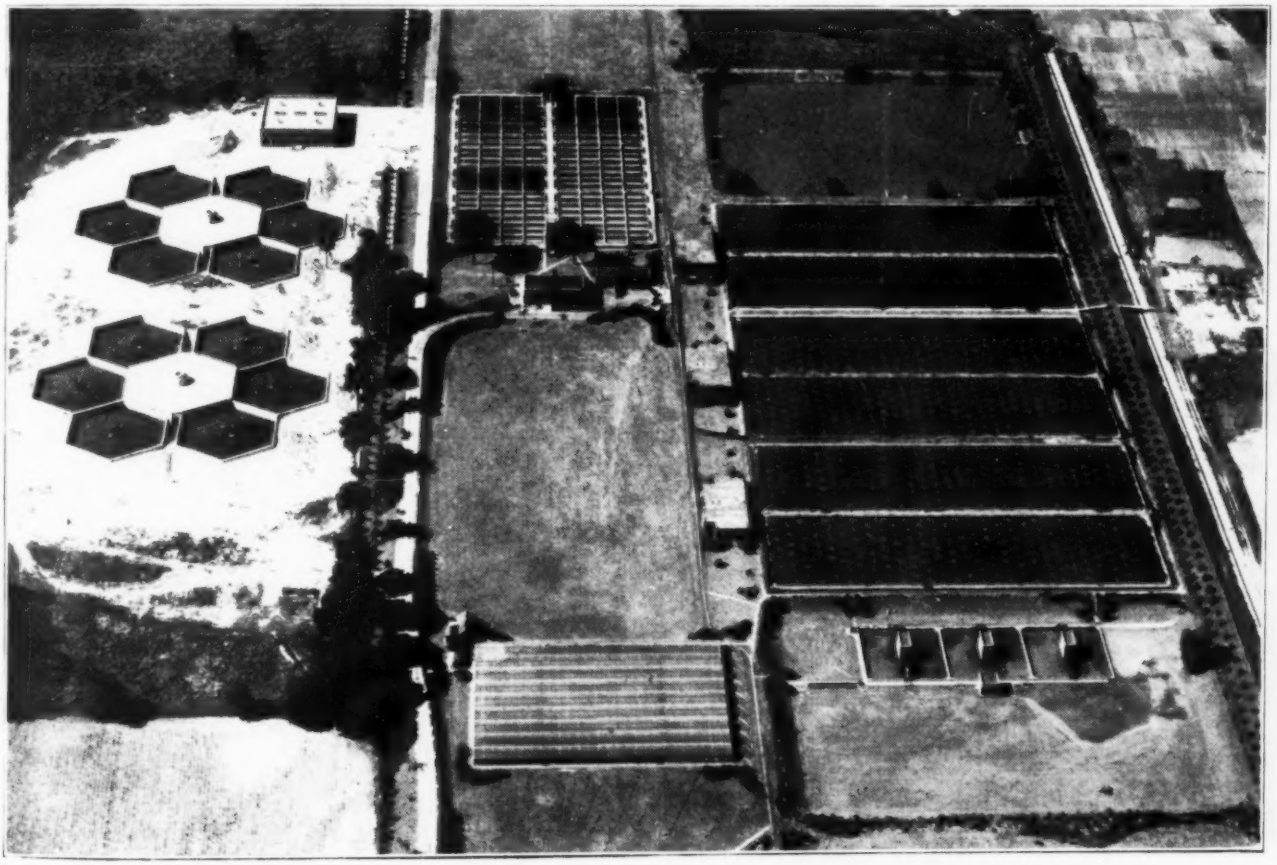


Fig. 5. Cleveland's Southerly Treatment Works and Sludge Processing Plant

Two batteries of heated sludge digesters appear on the left. In the background is the sludge distribution and dewatering building which is the terminus of the 13 mile sludge main from the Easterly Plant.

Table II

SLUDGE PUMPED

Year	Total Volume (Million Gals.)	Gals./M.G. of Settled Sewage	Dry Solids (%)	Dry Solids (Tons)	Cost/Ton Dry Solids
1940	252.50	8,400	2.97	31,205	$0.45
1941	219.59	8,450	3.04	28,760	0.55
1942	297.73	9,380	2.51	30,391	0.45
1943	298.76	8,690	2.41	28,588	0.58
1944	220.43	6,375	3.30	30,094	0.63
1945	224.16	6,814	3.30	29,803	0.50
1946	214.64	6,473	3.50	30,437	0.40
1947	213.93	5,888	3.80	32,684	0.48

4 times the corresponding losses resulting from water pumpage.

The advantages of pumping concentrated sludge are of such importance, particularly where digestion is used, that serious consideration should be given to the location of primary digesters at the pumping site in order to secure at least a partial digestion prior to pumping. Uniformity and sludge concentration could be greatly improved thereby, and it is quite likely that the ever present supernatant that would result could be treated to advantage best at the pumping site. The quantity of supernatant from primary or partial digestion is relatively small and presents a less vexing problem than the treatment of secondary digestion supernatant.

Summary and Conclusions

Townend[2] of Mogden, England, has reported 10 years of successfully pumping 5 per cent partially digested sludge some seven miles through 12 in. force mains without a measurable increase in friction loss.

Pearse[3] of Chicago has reported 14 years of successfully pumping 1.18 per cent mixture of activated and primary sludge about 17 miles through a 14 in. force main with a reduction of "C" from 141 to 93 during that period.

Cleveland now reports 10 years of successful pumping of a concentrated mixture of activated and primary sludge that has reached a yearly average of 3.8 per cent dry solids. The installation and frequent use of junction chambers has made practicable the pumping of concentrated raw sludges by maintaining a smooth surface on the inside of the force main through routine cleanings. The same principle is also readily adaptable to heat interchangers for sludge digestion when 6 inch diameter or larger pipe is used.

The high pressures required to pump viscous sludge can be justified because of the resulting lower water content of the sludge. Pumping hours have also been reduced 60 per cent and cost of pumping has been lowered approximately 30 per cent.

The use of partial or primary digestion at the pumping site is recommended as a means of increasing the concentration, the uniformity and the fluidity of the sludge to be pumped. The supernatant load would thereby be divided and treated to advantage at both intake and outlet sites. Additional air relief valves, and perhaps some other slight modifications to the force main, might be required in this case.

The assistance in preparation of this paper by Messrs. J. W. Ellms, Commisioner of Sewage Disposal and Frank J. Schwemler, Commissioner, Division of Utilities Engineering, Department of Public Utilities, is gratefully acknowledged.

Table III

ALL EXPENDITURES IN CONNECTION WITH OPERATION AND MAINTENANCE OF PUMPS AND FORCE MAIN

(Total Cost of Pumping Sludge)

Year	Operation	Maintenance	Power	Total
1940	3,762.31	6,160.77	4,225.12	14,148.70
1941	3,946.27	7,775.61	3,965.83	15,687.71
1942	4,294.49	5,562.39	3,901.84	13,758.72
1943	4,528.36	7,725.37	4,237.89	16,491.62
1944	4,638.90	10,806.85	3,554.35	19,000.10
1945	4,552.30	7,549.12	2,652.87	14,754.29
1946	3,844.95	5,554.49	2,626.86	12,026.30
1947	4,322.27	8,531.32	2,849.28	15,702.87

References

1. George B. Gascoigne, "Report Upon The Treatment of Sewage from the Easterly Sewage District, Cleveland, Ohio (1931)"—p. 12.

2. C. B. Townend, March 30, 1946, letter. Author's file. C. B. Townend, June 25, 1948. Author's file.

3. Langdon Pearse, "Advances in Sewage Treatment and Present Status of the Art." Proceedings A.S.C.E., Nov., 1942, p. 1574.

COMMENTS*

by

C. B. TOWNEND

Engr. in Charge

MOGDEN TREATMENT WORKS

MIDDLESEX. ENG.

I have been very interested to read your paper on "Sludge Pumping in Long Force Main" and note your ingenuity in overcoming the trouble you have had with choking of your 12 inch main. The cleaning machine has undoubtedly converted the pumping operation into a sound and economic undertaking.

Your proposal to install a first stage of digestion at the pump site would receive general approval in this country where opinion for many years has favoured digestion before pumping in mains of any considerable length.

The earliest known case is that of Birmingham where a 2½ mile length of 9 inch cast-iron main was constructed in 1902 and operated by steam driven ram pumps. This main was extended in 1907 to 4 miles in length, and a parallel pipe of 12 inches in diameter over the same distance was added at a later date.

Commenting on this pumping operation in a paper written about that time, Mr. John D. Watson, then engineer of the Birmingham Drainage Board, said "The task looked more formidable than it turned out to be, the sludge in its fermented state having been found to be more mobile than expected, a condition probably due to the innumerable gas-bubbles between particles acting upon it like so many ball-bearings."

In contrast with this experience, Manchester has had trouble with a main conveying undigested crude sludge in a pipe for a distance of only one mile or so, due to choking with grease, etc. Many similar instances have also occurred elsewhere.

Thus it appears certain that the grease factor is the principal reason for the difference in pipe resistance, although the gas bubbles may have some bearing on the question.

Here, at Mogden, the grease content of the crude sludge is reduced by the primary stage of digestion from 25% of the dry solids to about 8%. The grease removed by digestion consists of fatty matter of the kind

*Excerpts from a letter by Mr. Townend to Mr. Wirts.

which would cause chokage in a pipe line, whereas the 8% remaining consists almost entirely of unsaponifiable matter fairly evenly dispersed throughout the sludge. We have never found the slightest sign of grease adhering to the inside of our pumping main from Mogden to Perry Oaks.

As to the question of current pumping losses, the present pumping rate at Mogden is 550 gpm (660 U. S. Gals.) with a velocity of 1.87 ft. per second in the 12 inch main, the friction loss then being 11 feet per mile, or about 1.4 times that of water, with sludge solids at 3 to 4% as taken from the digesters.

Some figures were recently published for the 4 mile Birmingham main (12 inch) giving the friction loss at 2.6 times that of water with sludge solids at 8.5 to 10.25%. The Birmingham material is an industrial sludge from a completely combined sewerage system.

The Mogden case is very similar in many respects to that of Cleveland. Our average production of sludge was 190,000 lbs. of dry solids per day in 1939 and has now returned to about the same figure. This is equivalent to 34,700 tons per annum, or very much the same figure as your own. We equally carry out our pumping in 12 hours. The point of difference is that by digesting at Mogden, we reduce the pumpage of solids by about 35 to 40%.

Regarding the deposit of grit, although we have what is considered to be adequate arrangements for grit removal before sewage sedimentation, we have been surprised to find substantial deposits in the digestion tanks. We have not come to a final conclusion as to the reason for grit arriving at this point, but it is clear that the digestion tanks do protect the pumps and sludge force main from the effects of grit.

I have looked through the Cleveland figures and as far as I can judge, the friction head immediately after cleaning the main is no more than at Mogden; in fact, sometimes it appears considerably less, taking into account the higher velocities employed. The only difference is that the Mogden pressures have never varied to any measurable extent during 12 years.

Regarding supernatant water, which can not always be separated, we pump the whole volume of the original crude sludge to Perry Oaks, whether in the form of digested sludge or supernatant water.

Our average sewage flow is now about 85 mgd (U. S. gals.) but in view of our lower water consumption in this country, that figure may not convey a balanced impression of the scale of the works which now serve a population of nearly 1,400,000. On the other hand, our impurity load is no more than it was in 1939 when the population was 1,170,000 only. The reduction of about 16% in the impurity per capita is due to rationing of foods, soaps and so on.

J. J. Baffa Moves Offices

John J. Baffa, Consulting Engineer, New York City, has announced the removal of his offices to a new address. Mr. Baffa's office is now located at 75 West Street, New York 6, N.Y.

Water Works School At Penn State

Definite plans have been made to hold a school for water plant operators and superintendents at Pennsylvania State College, in State College, Pennsylvania, on October 25 to 29th.

The school will be under the direction of the Sanitary Engineering Division of the College and is sponsored by the Pennsylvania Water Works Operators Association and the Pennsylvania Department of Health.

Registration will take place on Monday, October 25th, and the registration fee is $15.00. The University is extending an invitation to any interested persons from any state or Canada, but because of certain physical limitations, only the first 100 applicants can be admitted.

Programs, application blanks and other information may be obtained from the Sanitary Engineering Division of Pennsylvania State College, State College, Pennsylvania. The work will be under the direction of Professor R. E. Stiemke, Sanitary Engineering Division.

Dr. Christensen Appointed Director Cornell School Of Civil Engineering

Dr. Nephi Albert Christensen, Dean of Engineering at Colorado State College, Fort Collins, Colorado, has been appointed director of the School of Civil Engineering at Cornell University. Dr. Christensen will succeed Professor Carl Crandall, who has served as acting director since the death of William Lindsay Malcolm in January.

Construction Increases

According to *Public Construction* issued by the Federal Works Agency of Washington, D.C., in July 1948, construction has gone ahead rapidly this year as compared to last year.

For the first five months of 1948, sewage works construction totaled $88,889,000 as compared with $56,954,000 for the same five months period in 1947.

Water supply facilities totaled $81,646,000 in the first five months of 1948 as compared with $49,937,000 in the same period last year.

It is also interesting to note that whereas sewage works construction in May 1948 was but little more than the sewage facilities construction in May 1947, the construction of water supply facility in May 1948 of $37,874,000 was more than four times as much as construction of water supply and facilities in May 1947.

Newark Tries Ground Water Recharge

In an attempt to conserve the capacity of the surface supply and the dwindling ground water supply in and around North Jersey, the Newark water dept. engineers have been experimenting with ground water recharge.

Newark has a daily supply of 100 mil. gal. in its Wanaque and Pequannock reservoirs and is using an average of 81 mgd. Expanding industry is drawing most of its supply from wells, and lowering the ground water level to an alarming degree. Not wishing to endanger the surface water supply by overdraft, the water department engineers have been pumping the excess surface water to the depleted ground water pool.

The pumping has been into a local Ballantine brewery well and some 200 mil. gal. of overflow water from the surface supply have been discharged into the well. The cost is some $3 per mil. gal. and the water level which has gone down 100 feet in 25 years has actually been raised in some instances. The temperature of the ground water supply will be improved because the excess supply is more abundant in the winter time and most of the recharge will take place during that period. This will lower the ground water temperature, a condition which is of considerable interest to the industry.

ANNUAL REPORTS OF INTEREST

The following brief abstracts have been made of annual reports received within recent months. Copies of the reports may be obtained by writing to the superintendent of the department or plant in question.

Water Supply

Athol, Mass.; 1947. (20 pages.) Supt., R. W. Glasheen. Extension of service included 4,137 feet of pipe, four new public hydrants, 50 new meters, 53 new services and 27 renewed old services. Total consumption of water for the year reached 804,218 gal. per day, an increase of 250,000 gal. per day since the plant was built in 1937. During the same period there was an increase of 375 services. Bonds outstanding at the close of the year amounted to $3,000,000. Final payment of the debt is expected in 1950.

Auburn, Me.; 1947. (30 pages.) Supt. Lyndall K. Parker. Extension of services totaled 9,000 ft. of main, and 141 new services. $60,000 bond issue was matured in 1947 and retired. Pumpage averaged approximately 1.25 mgd.; 11 main leaks and 20 service leaks were found and repaired. No reforestation planting was done on the water shed; 100 cords of wood were sold. Total operating income was more than $77,000 and operating expenses $61,800; net income was approximately $3,000.

Denver, Col.; 1947. (73 pages.) D. D. Gross, Ch. Engr. Construction, included a 24,000,000 gal. reinforced concrete reservoir, and replacing of a 30 inch wood stave line by reinforced concrete pipe. 19½ miles of new distributing mains were installed and 5066 new services were added, bringing the total number to nearly 92,000 customers. Per capita consumption was 183 gal. per day, slightly down from the previous year. The slow sand filters were renovated. Work is continuing on the construction of the Montezuma Tunnel, and the conduit line that will bring water from the Ranch Creek to the Moffat Water Tunnel.

The payroll totals more than $1,000,000 a year. Of the total operating revenue, 33½ per cent goes to operation and maintenance, 16.8 per cent to depreciation, 39.18 per cent to interest and bond retirements, and 10.43 per cent to investment capital. The report contains complete tabular data and graphs, showing information on physical operation, new services, cost of operation, etc., by years since 1919.

Des Moines, Iowa; 1947. (28 pages.) Dale L. Maffitt, Gen. Mgr. Operation cost exclusive of fixed charges increased 17.9 per cent over the previous year, whereas the gross income increased only 10.5 per cent, while the total consumption increased 14.3 per cent. Daily pumpage is 20.5 mgd. or 111 gpcd.; 81.6 per cent of the water pumped is metered. One table of general statistics shows comparative data for 1946 and 1947 in every conceivable manner desirable, including income per capita, per mile of pipe, per service, per mil. gal. pumped, etc.

Little Rock, Ark.; 1947. (85 pages.) L. A. Jackson, Mgr.-Engr. Capital expenditures during the year for extensions and improvements amounted to $388,935 as compared with $621,810 the previous year. To meet increased consumption demands, plans were begun to increase the capacity of the filter plant from 15 to 23 mgd. Total operating revenue was $78,250 (plus $3,342 non operating revenue), operating expense $50,291, net income $28,532. Consumer growth continued; 411 consumers being added during the year for a total increase of 48 per cent since the city took over management of the water department in 1936. Water department operates a fish-rearing pond; the fish, generally bream and bass, are removed and distributed throughout the state. Average daily pumpage 128 mgd.

"Look at the water, Joe. You can see through it!"

They Could Be From the Island of Manhattan.

Sewage Treatment

Aurora, Ill., Sanitary District; 1947. (62 pages mimeographed.) Walter A. Sperry, Supt. Plant is completely dependent on its own power, most of which is supplied by gas engines, for pumping and generator operation. Auxiliary gasoline amounted to 1,292 gal. but on the basis of power saved, the earnings of the engine installation was slightly more than $4,000. These engines have now been in operation 141 months; original cost was $18,321. The installation of gas engines for power is earning about 22 per cent a year on the original investment. Average daily flow 7.4 mgd., an increase of 18 per cent over previous year. Total lbs. of solids removed in the year 3,665,700, for a removal of 85 per cent. B.O.D. removed, 2,351,820 lb. during the year, for removal of 79.4 per cent, operating cost $47,335 an increase of approximately 18 per cent over the previous year.

Gary, Ind. Sanitary District; 1947. (58 pages mimeographed.) W. W. Mathews, Supt. Population served 100,000; sewage pumpage 19.86 mgd. or 198.6 gpcd. Suspended solids removed averaged 0.199 lb. per capita per day; B.O.D. removed averaged 0.207 lb. per capita per day. Plant designed for 170,000 population and 40,000,000 gal. flow. Primary clarification plus activated sludge with secondary clarifiers. Gas production 1.61 cu. ft. per cap. per day, or 2.7 cu. ft. per lb. of solids added, or 5.2 cu. ft. per lb. of volatile solids added. Value of gas used for engine operation $24,062. Suspended solids removal averaged 98.3 per cent; B.O.D. removal averaged 93 per cent. Cost of operation approximately 85 cents per capita. Dried sludge removed from beds approximately 3,000 cubic yards.

Marion, Ind.; 1947. (27 pages.) David Backmeyer, Supt. Plant sells digested sludge as liquid farm fertilizer; revenue totaled $1,486 in 1947. Plant operation cost $49,051 plus amortization and permanent improvements, total income was $94,713, with a net cash profit of $13,411. Estimated value of gas produced and used for fuel $10,730. Approximately 15 per cent of the gas produced is attributed to ground garbage solids added to the digesters. 90.2 per cent removal of B.O.D.; suspended solid reduction, 89.5 per cent. Dry solids removed for fertilizer 955 tons. Average pumpage 4.54 mgd.

DISPOSAL OF LIQUID DIGESTED SLUDGE AT MARION, IND.

by
DAVID BACKMEYER
Superintendent
CITY WATER AND SEWAGE WORKS
MARION, IND.

THE sewage treatment and garbage disposal plant at Marion, Indiana, was completed and put in operation in July of 1940. The plant design provides for primary sedimentation, secondary activated sludge treatment, and separate sludge digestion for the combination of raw sewage sludge, waste activated sludge, and ground garbage solids. The actual resident population of the community served is about 30,000, but a wide variety of industrial wastes brings the sewage load to an equivalent of 41,000 population.

It is the purpose of this paper to present an analysis of the various factors involved in the removal of the digested sludge solids in liquid form by means of tank trucks. The original plant design called for the removal of solids as filter cake after chemical processing and de-watering on the vacuum filter. When operations were first begun, this method was used for a period of 27 months, at which time it was discontinued in favor of the liquid disposal system. The first liquid sludge was hauled in March 1943, and the vacuum filter has not been operated since that time. Because of the proximity of the treatment plant to industries and homes, the use of open drying beds at the plant site has never been regarded as a satisfactory substitute for either of the disposal methods mentioned above.

The Author

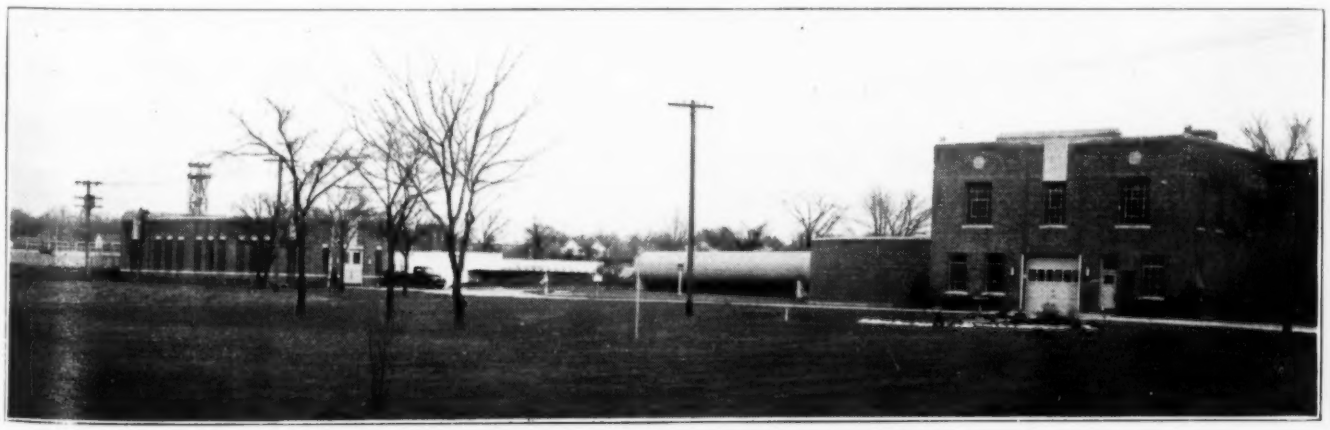
Solving the Problems

Throughout the five year period that liquid sludge disposal has been practiced at the Marion plant many different problems have been encountered. We have had an opportunity to investigate and work out the solution to many of the problems by trial and error methods which in some cases have been rather costly. The writer realizes this type of sludge removal has its limitations, and therefore no effort will be made in this article to promote or sell the system as a general method of solids disposal applicable to all sewage treatment installations. It is believed, however, that the method used here at Marion has many merits which should recommend it for investigation by sanitary engineers engaged in the design of sewage treatment facilities.

The success of any method of sludge disposal depends to a large degree upon its adaptability to the general scheme of operation of the other plant units. As an example, the use of the vacuum filter required the purchasing of expensive chemicals and the employment of specially trained personnel for filter operation at our particular plant. The substitution of liquid disposal for vacuum filtration eliminated both of these problems. Digested sludge from the bottom of the secondary digester is pumped by plunger type pump to the 1,500 gallon capacity tank truck at a rate of 160 gallons per minute. The truck driver loads the truck and shuts off the flow by remote control at the truck loading ramp. This is a simple operation which is almost trouble proof. It requires no special skill and very little effort on the part of the employee in charge of the truck. The sludge is handled in a sanitary manner as far as the plant site is concerned. The loading line is located at the rear of the plant, and the use of a quick-opening type valve makes possible the loading of the tank without creating any fly or odor nuisance.

Equipment and Costs

The investment in equipment is not excessive when comparison is made with other disposal methods such as vacuum filtration, open or covered sand beds with the necessary drainage piping, disposal by barge at sea, etc. The equipment used at Marion consists of two tank trucks. One is a heavy duty two ton unit with 1,500 gallon tank, and the other is a regular 1½ ton chassis with 1,000 gallon tank. If purchased at today's prices, the larger truck would cost about $4,000 complete with tank, and the smaller unit approximately $3,000 with tank. Either one of the trucks could handle the plant load where the



Marion, Indiana, Sewage Treatment Works

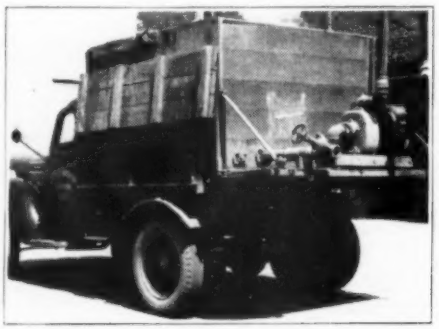
digestion tanks were operating under normal loading conditions. A stand-by unit is always held available for use in case one of the trucks has to be taken out of service for mechanical troubles.

One item of expense that must be included in our costs, but which is probably peculiar to our local conditions, is the requirement for lagoons or storage ponds into which the sludge can be dumped when the ground is too soft for the trucks to make deliveries to the fields. The digestion system at Marion is badly overloaded. No clear supernatant can be withdrawn from the digesters for periods ranging from thirty to ninety days. For this reason each gallon pumped into the system must be removed as digested sludge without the advantage of any solids concentration resulting from supernatant removal. The average dry solids content of all the digested sludge removed during the year 1947 was only 2.84 percent. To cite a typical month, in August of 1947, a total of 800,400 gallons was metered into the digestion system, and 834,500 gallons were removed by tank truck in 597 loads. This volume represented only 101 tons of actual dry solids. Assuming 40 percent withdrawal of supernatant from the digestion system, the 101 tons of solids could have been handled in 500,700 gallons or 330 truck loads. Since sludge must be hauled from the overloaded plant every day, a lagoon must be available for receiving the liquid in wet weather. Several such pits located within one mile of the plant are available for use at a rental cost of from 50 to 100 dollars annually. In some cases a farmer will set aside an acre of level land for sludge storage use under an agreement by which he is permitted to remove all sludge cake from pond during the dry summer months for use on his own farm fields.

Advantages

Perhaps the single outstanding advantage in favor of liquid sludge disposal at Marion is the ready market for this fertilizer product. Many farmers who were skeptical of the liquid product when it was first introduced are now active in promoting its sale to their neighbors. Among our customers are the three largest dairy farms in the county. The owners of these farms operate them on sound business principles, and they would not continue to purchase liquid sludge year after year if it did not pay dividends as a grass fertilizer. Let us analyze the system as it now operates and see why this demand for liquid sludge exists.

To begin with, the fertilizer is put on the farm land where the farmer wants it with no inconvenience or cost to him for distribution or handling labor. If a ten acre field is to be covered, the farmer merely opens the gates to the field, and our truck driver does the rest of the job. The usual application consists of about 7,500 gallons of sludge to the acre. This coverage will usually supply sufficient plant food for two seasons, and many of the farmers do cover their pasture and hay fields regularly every third season. Secondly, we can sell nitrogen and phosphate to farms close to the plant at a considerable savings in cost as compared to commercial products. The charge for liquid sludge is 10c per mile driven by the truck for delivery of 1,000 gallons. A farmer located three miles from the plant will pay 60c for the 1,000 gallon tank load or 90c for the large 1,500 gallon tank load. This charge, of course, does not cover all of the expense involved in the delivery of the sludge. It does, however, defray part of the operation costs chargeable to sludge removal, and at the same time restocks the farm land with badly needed plant food and humus material.



Original Tank Truck with Pump Mounted on Rear

Know the Farmer's Needs

Most of the farmers with whom we deal today are profit minded as well as soil conservation minded. To gain his confidence as a supplier of his plant food demands, we must know considerable about the farmer's business. If he comes to our office for information, we must be able to give him definite facts as to the proper application of our product. Many times farmers want to apply liquid sludge on open fields in the winter time when the ground is frozen. In most cases we advise against winter fertilization of fields that are not protected with a cover crop as this type of land will be subjected to the leaching action of spring rains and the fertilizer purchased by the farmer will be washed away before he is able to recover it through his crops.

After we have covered a field, we should be able to give the customer a written estimate of the material he has received. As an example, the following report was sent to one of our dairy farmers last fall:

Number of acres treated	11a.
No. of loads per acre (av.)	5.5
Total number of loads delivered	60.
Total pounds of dry solids delivered (from 90,000 gal.)	19,500
Pounds dry organic solids	10,75)
Pounds total nitrogen in solids	520
Pounds phosphate in solids	505
Estimated value of nitrogen at market price 15c per lb.	$75.75
Estimated value of phosphate at market price 5c per lb.	$25.25
Total value of nitrogen and phosphate	$101.00
Total cost of sludge on field	$ 63.00
Investment per acre for sludge fertilizer	$ 5.73

The estimates made are based on samples analyzed daily at our plant laboratory, and on fertilizer analysis reports from Purdue University, as shown in the typical analysis below:

Total nitrogen	2.66%
Water-insoluble organic nitrogen	2.58
Active insoluble organic nitrogen	1.41
Total P_2O_5	3.7
Water-soluble potash	0.0

We have always been extremely careful not to misrepresent our product in any respect. The farmer should be advised that if his land needs the third essential plant food, potash, he will have to supplement our fertilizer with this material. We do not make deliveries to farms that are more than five miles from the plant for two reasons. One, the time required for these trips is too great, and as a result a sufficient volume cannot be removed daily from the digesters. Two, the cost for the long trip delivery reduces the cash advantage to the farmer to such an extent that he can use commercial fertilizers more profitably. We have been forced to refuse many customers because of these limitations.

Public Health Aspect

The public health and sanitation aspect of any method of sewage solids disposal is always of prime importance. When the first deliveries of liquid sludge were made in 1943, a portable pump was mounted on the tail gate of the tank truck for the purpose of unloading through pressure hose to garden lots and lawns. This practice has been discontinued, and our present trucks are unloaded by gravity. (See photo.) The possibility of disease transmission to humans by the use of vegetables grown

in gardens fertilized with sludge is also eliminated under the present set-up as we now limit our deliveries to farm fields which will not be planted in root type crops.

Costs and Return

What is the future for this method of sludge disposal, and what are some of the problems yet to be solved if the system is to be used economically? To answer these questions, let us look at the accompanying table, which gives the operation figures for the year 1947. In the column at the left it will be noted that a total of 4,721 loads of liquid were hauled during the calendar year. Of this total, 3,157 loads or 66.7 percent were hauled to our lagoons, and no income was available from this sludge. The remaining 1,564 loads that were sold (33.3 percent of the total) brought in a total income of $1,486.65, which when prorated over the entire volume hauled gives a return of $1.56 per ton dry solids removed. In figuring the costs per ton for dry solids removal, a maintenance of equipment item is shown which includes repairs for the truck, lubrication, depreciation of the unit, and $100 rental for the storage lagoon. The total charged for maintenance on the big truck is $1,150 per year. This figure is based on our truck operation record and includes an item of $440 as a fixed charge for replacement of the truck after seven years' service.

In the column headed "Total miles driven per load hauled," it will be seen that during four months in particular, namely May, June, November, and December, the distance traveled per load was about 2.1 miles. This is due to the fact that sludge could not be dumped on the farm land, because of wet weather conditions, and as a result most of the liquid was taken to the storage lagoon. The column at the right hand side shows an overall cost of $4.25 per dry ton of solids handled. There is no allowance made in this estimate for pumping from the digester to the truck, or for maintenance of the pump used for this work. In some installations it might be possible to fill the truck by gravity flow, eliminating entirely the need for sludge pumping when the trucks are loaded.

Marion's Tank Trucks for Distributing Liquid Farm Fertilizer

It is the opinion of the writer that the cost figure $4.25 could be greatly reduced were it possible to *control* the removal of solids from the digestion system. Let us consider an ideal situation in which the digestion capacity is sufficient to permit storage of the solids in the periods when delivery to farm land cannot be made because of inclement weather conditions. If, for example at our plant, all the sludge solids were concentrated to a density permitting 50 percent removal (as supernatant liquor of quality returnable to primary settlers) of all liquid pumped to the digestion system, then the volume to have been hauled by truck would have been reduced by 50 percent, and it might have been possible to have gotten 100 percent removal to farm land. In this instance the average solids concentration of all the finished sludge removed would have been 5.68 percent. We would then show a 50 percent reduction in cost for both gasoline used and truck labor hired, and an estimated 25 percent reduction in truck repair costs, making the average total cost for all three items $3.19 per dry ton. Assuming the gross income from sales of sludge to be the same, the average revenue from a ton of solids would not be changed since the former figure was pro-rated over the tonnage removed during the entire year. By subtracting the revenue figure of $1.56 from the overall cost figure $3.19 a net cost of $1.63 is realized. This figure becomes quite attractive when we refer to the operation records of 1941 and '42 and note that the average cost of chemicals for the filtration of the sludge amounted to $1.83 per dry ton solids removed. Our experience at that time indicated that little if any revenue could be expected from the sale of the filter cake as it came from the filter.

Future Developments

The possibility of the development of a method of unloading the tank trucks by the use of high pressure is yet to be explored. The trucks could then be parked on solid roadways,

DATA ON LIQUID SLUDGE DISPOSAL IN 1947

Month 1947	Truck loads 1500 gal. cap.	Tons dry solids removed	Gasoline cost/ton dry solids removed	Truck labor cost/ton dry solids removed	Miles driven/ load of sludge	Miles driven per ton of dry solids removed	Total cost in cents*/mile	Cost/ton dry solids removed*	Net cost/ton** dry solids removed
Jan.	339	50.5	$0.82	$ 5.62	3.6	24.0	32.4	$ 7.78	$ 6.22
Feb.	469	80.9	0.67	3.23	3.0	17.2	30.5	5.24	3.68
Mar.	404	66.6	0.80	4.39	3.5	21.3	30.6	6.53	4.97
April	No solids were removed as digested sludge as supernatant was returned to primary tanks***								
May	325	65.9	0.39	3.45	2.1	10.1	51.3	5.18	3.62
June	434	101.3	0.35	2.54	2.1	9.2	46.0	4.23	2.67
July	472	102.5	0.80	3.08	4.3	19.6	26.6	5.22	3.66
Aug.	475	87.0	0.78	3.30	4.3	23.4	23.2	5.42	3.86
Sept.	370	67.5	1.03	3.30	5.5	30.3	18.7	5.67	4.11
Oct.	492	73.5	1.30	4.04	4.8	27.8	24.0	6.68	5.12
Nov.	341	50.6	0.84	3.97	2.2	15.1	40.7	6.15	4.59
Dec.	600	90.7	0.64	3.89	2.0	13.2	44.5	5.87	4.31
TOTAL	4,721	837.0	8.42	39.81	37.4	211.2	368.5	63.97	46.81
Avg.	429	76.1	0.76	3.62	3.4	19.2	33.4	5.81	4.25

*Includes gasoline, labor, and maintenance. The maintenance item included here is a pro-rated charge of $1.34 per dry ton solids.

**Net cost after deducting pro-rated revenue of $1.56 per ton for sludge sales.

***Organic load in sewage was low due to dilution from excessive rain water this month.

Tank Trucks in Action During Winter

and the sludge discharged through nozzles at 65 psi. pressure to the fields that were to be fertilized. This system would not be subjected to the wet weather limitation. It would be more costly since additional equipment in the form of centrifugal pumps or compressed air ejectors would have to be used. To date no investment has been made in this type of specialized equipment. The design work including plans and specifications for additional digestion capacity amounting to an increase of 50 percent over the present volume is now completed. This additional digestion capacity should permit the concentration of solids and the control of the removal of solids from the digestion system. It may then be possible to approach or even better the $1.63 per dry ton cost figure which is based on so-called ideal digestion operation conditions.

U.N. 1949 Program Includes Water

A provisional program of the United Nations Scientific Conference on the Conservation and Utilization of Resources is scheduled to be held in the United States in May and June 1949.

According to David Owen, of Lake Success, who is Assistant Secretary-General in charge of Economic Affairs, the program has tentatively scheduled to include such subjects as water resources, water shed management, cost and benefits of water development.

Md.-Del. Association Postpones Short School

At the April meeting of the Maryland-Delaware Water & Sewage Association held in Baltimore in April there was considerable discussion as to the need for and advantages of a short school. The consensus of opinion was that there should be a short school held in 1948.

A committee on this matter has met with the State Dept. of Health, the University of Maryland and representatives of Johns Hopkins, and it has been ascertained that facilities will not be available for holding such a short school for water and sewage works operators in 1948.

Plans are going forward however to hold a short school in 1949 at the University of Maryland where available laboratory and classroom facilities as well as meal and room accommodations are planned for. The State Dept. of Health will participate in and help sponsor the short school.

Comparative Bacterial Kill With Chloramine and Free Chlorine

In the July 16, 1948 issue of Vol. 63, No. 29, of the Public Health Reports issued by the U. S. Public Health Service, appears an article on the bactericidal properties of chloramine and free chlorine in water. The article is authored by C. T. Butterfield, Head Bacteriologist, Water & Sanitation Investigations Station, Public Health Service, Cincinnati, Ohio.

In the article, Mr. Butterfield outlines many experiments which led to the conclusion that the bactericidal efficiency of both free chlorine and chloramine are dependent on the time of contact, the temperature, and the pH of the water.

Mr. Butterfield also found that to obtain 100 per cent kill within the same contact period required about 25 times as much chloramine as free chlorine, or stated in another way, to obtain 100 per cent kill using the same amounts of residual chloramine and residual free chlorine, requires approximately 100 times the contact period for chloramine.

Reprints of this article may be obtained from the United States Government Printing office, Superintendent of Documents, Washington 25, D. C., for ten cents.

Texas Sanitation Group Meets

The Capitol Area Water & Sanitation Association held an all day meeting in Austin, Texas, late in July. Under the presiding gavel of L. G. Glover, President, and G. G. Medders, Vice President, the members participated in several round table discussions, and listened to four papers.

Round table discussions included: Meter Service, led by Marvin C. Turner, Consulting Engineer, Austin; Sewer and Pump Problems, led by Asa E. Hunt, Manufacturer's Agent, Dallas.

In the afternoon session papers consisted of: Sewage Disposal Lagoons, by Jack Myers, Asso. Prof. of Zoology, University of Texas, Austin; Water Well Design, by M. T. Rowland, Layne-Texas Company, Dallas; the State Plumbing Law by C. E. Belk, Administrator, Texas State Board of Plumbing Examiners, Austin; Mechanical Chemical Feeders, by Jeff Corydon, Majax Company, Waco. E. J. M. Berg, Director of the Texas Sewage Section, spoke on the Federation of Sewage Works Associations, its Objectives, and its Functions.

The evening program consisted of a barbecue, entertainment and dance, as compliments of the San Antonio Machine & Supply Company.

DIGESTION OF SEWAGE SOLIDS

A Review of Established Methods; Comparisons and Comment

OPERATION OF HEATED SLUDGE DIGESTERS

The Sixth Article of a Series

by
LEROY W. VAN KLEECK
Sanitary Engineer*
HARTFORD, CONN.

IN THIS sixth article of a series devoted to the "Digestion of Sewage Solids" the following topics will be discussed:

1. Liming of digesters.
2. Starting new tanks.
3. Operating an established digester.
4. Controlling scum.
5. Handling of supernatant overflow liquor.
6. Safety precautions.

The reader is referred to any of the numerous pamphlets or books describing the details of digestion tank operation. The present discussion is limited to those phases of operation that the writer's experience has shown to be of particular importance.

Liming of Digesters

Liming of septic tanks, Imhoff tanks and unheated separate digesters has already been suggested in previous articles of this series for certain operating conditions. It is also suggested under *certain* conditions for heated digesters. In the light of recent research this may be considered unsound, and some have gone so far as to recommend against all liming. Lime has undoubtedly been used too indiscriminately in the past. In some instances the use of lime has reduced methane production and resulted in lumping of lime in tank bottoms, not to mention the expense and the work involved in its application. Checks with and without lime additions are now in progress at several Connecticut plants where an apparent need for liming has been indicated in the past.

Regardless of the good and the bad of liming, the writer still recommends lime for overloaded digesters (including Imhoff tanks), and for starting up digesters without seed, because the method has aided in preventing foaming and avoiding nuisance at numerous plants over a period of nearly 20 years. Reports of foaming tanks,

The Author

odorous sludge and poor overflow liquor are not infrequent at plants starting under full load without lime. If the digesters can be fed raw sludge gradually until seeding material is built up and are not subsequently overloaded, lime may well be omitted. The latter procedure is, however, not always practical nor possible.

Starting New Tanks

Efforts to seed digesters at new plants with ripe sludge have not usually been successful because of an insufficient volume of ripe sludge. It will rarely prove economical to haul the large quantity of digested sludge required for starting the average-sized digester, because such quantity should be not less than 20 per cent by volume of the digester's capacity.

In 1933 the writer reported on a method[1] of starting digestion tanks, which avoids foaming, controls odors, and produces both seed sludge and burnable sludge gas within 30 days. This method has been used repeatedly with consistent results.

The method in brief:

1. Fill the digester to the overflow level with sewage (in the case of a floating cover digester, until the cover rises) before adding any sludge. The slow filling of new (empty or partially filled) digesters with raw sludge is an occupational hazard of the first order, because of the possibility of sludge gas and air forming an explosive mixture, and should never be practiced. In other respects slow filling would have much merit, as there is no foul overflow liquor problem, the sludge becomes more concentrated, and mixing of raw and seeded solids is easily accomplished.

2. Heat the tank contents to at least 80°F. This temperature rise is attained before adding raw sludge. Maintain a temperature around 80 to 85°F. for the first thirty days, then increase the temperature to between 95 and 100°F., if possible, for future operation.

3. Add the daily full load of fresh raw solids mixed with milk of lime. If the tank can receive rest periods or very light feedings of raw solids, liming can undoubtedly be omitted. Most plant operators are unable to follow this procedure, because only one digester is available, and plant processes cannot be shut on and off without nuisance, or for other varied reasons.

Facilities of one kind or another are usually available for adding milk of lime to the raw sludge. The primary settling tank skimmings-well is one convenient means, and at least one manufacturer's design (with circular tanks) permits mixing of raw sludge and lime at this point. Otherwise the lime slurry can be pumped to the digester with skimmings and sewage after pumping sludge. Another means for mixing lime with raw sludge, which can be cheaply and quickly installed by an operator of a small plant, is to erect a small lime feed-tank with shut-off valve on the suction side of the sludge pump. If pipe sizes are adequate and discharge distances relatively short, a fine grade of hydrated lime powder, such as finishing lime or spray lime, can be substituted for the milk of lime. Such lime is dumped directly into the mixing chamber and pumped with sewage or sludge to the digester. While preparing a milk of lime suspension involves more labor, its use will preclude pipe stoppages

*Connecticut State Dept. of Health.

(1)—*Sewage Works Journal*, July 1933, Vol. 5, No. 4, p. 635.

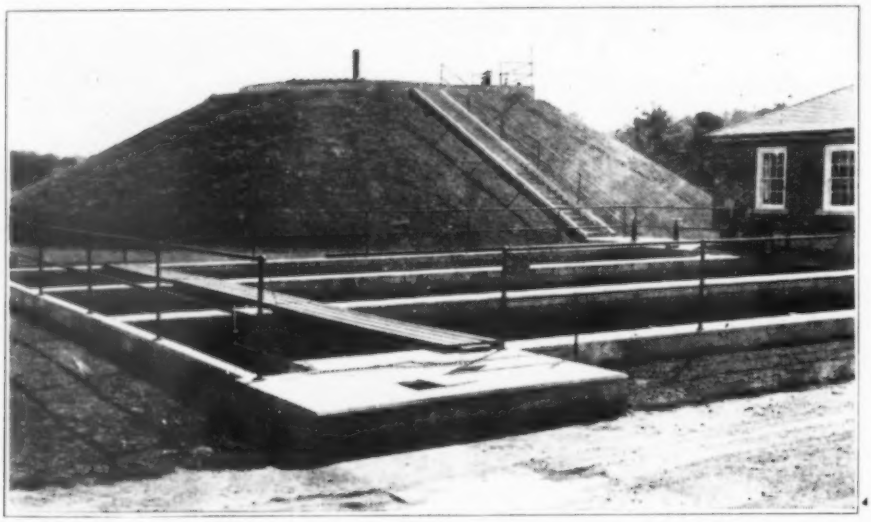


Fig. 1—Typical Separate Sludge Digestion Plant—Putnam, Conn.

Heated digester with floating cover and protected by earth embankment.

and lime pockets, and results in better distribution of the lime throughout the sludge.

If no other means for adding lime is available, dry lime can be mixed with the digester supernatant in the cover manholes, or preferably milk of lime can be added through these manholes at the top, and into a lower level with rain leader pipe.

4. The quantity of lime will vary at each plant. A moderate sized plant, say one in the population range of 25,000, may require six to eight 50-lb. bags of lime daily at the start. This will taper off after 2 or 3 weeks until none is required. The important thing is to maintain the pH around 6.6 to 7.0 by regular lime additions. Permitting the pH to drop to 6.0 and lower leads to trouble. Rudolfs at the New Jersey Experiment Station confirmed this many years ago in the laboratory; the writer has since confirmed it many times in the field. It must be realized that a sludge of pH 6 is ten times more acidic than a sludge of pH7.

5. Circulate the bottom limed sludge to the top or center of the tank several hours daily at the start.

For a short time the overflow liquor and gas will be vile smelling, but in about a month this odor will decrease, the gas will burn, black digested sludge will begin to build up, and the starting headaches of many an operator will be avoided.

Operating an Established Digester

1. Add concentrated fresh raw solids frequently. Do not permit primary sludge to become septic. Fresh solids have less effect on the total alkalinity balance in digesters. Regular frequent feedings of the bacteria and micro-organisms in the tank are necessary; they must be fed gradually and frequently if they are to thrive and do their work effectively.

By introducing only concentrated sludge (whether primary, trickling filter, humus, waste activated, or chemically precipitated) the volume of overflow liquor will be reduced. Large volumes of overflow liquor add to the burden of primary settling tanks, increase the chlorine demand of the plant effluent and create demands for oxygen. Water streaks in the pumped sludge are an indication that it is too thin. Some plant operators weigh samples of the raw sludge on a pan balance and stop pumping operations below a predetermined weight. Time clock control of the sludge pumps is another method of obtaining both concentrated sludge and frequent tank feedings. Fig. 4 shows a typical plunger type pump used for pumping raw sludge. By the use of the sampling device seen in this picture the operator of a small plant can observe the character of the sludge at frequent intervals and stop pumping operations when the sludge becomes thin.

2. As with Imhoff tanks, draw digested sludge from heated digesters frequently and in moderate amounts. This assures adequate seed sludge in the tanks at all times. The total alkalinity of the tank sludge (as determined by acid titration) should be maintained above 2000 ppm. if possible. The pH can safely drop to 6.6 or 6.7, although it is possible that the gas production will be somewhat affected. Theoretically a pH range of 7.0 to 7.4 is considered desirable, but this is rarely obtainable in the writer's experience with present-day tanks without lime additions, nor is such a high range necessary for successful operation. If volatile acids are determined, a value under 2000 ppm. should be the aim. This test requires distilling equipment and a titration procedure, so that many operators of small plants will continue to find the pH or total alkalinity test easier to perform and preferable. Table I shows the results of examination of a number of samples of digested sludge from heated digesters serving Connecticut communities.

3. In parallel operation, normally all tanks in service should be fed equal volumes of raw solids. In series operation, all raw sludge goes to the primary units with about 75 per cent of the displaced primary volume taken from the top and the remainder removed at intervals from the bottom to

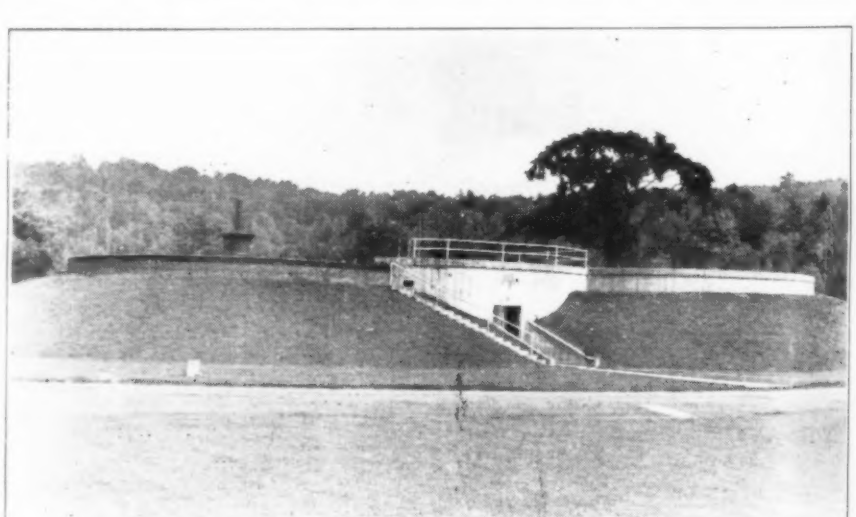


Fig. 2—Modern Two-Stage Digestion Plant—Torrington, Conn.

An operating gallery separates a heated fixed-cover primary digestion tank and the unheated open top secondary digester.

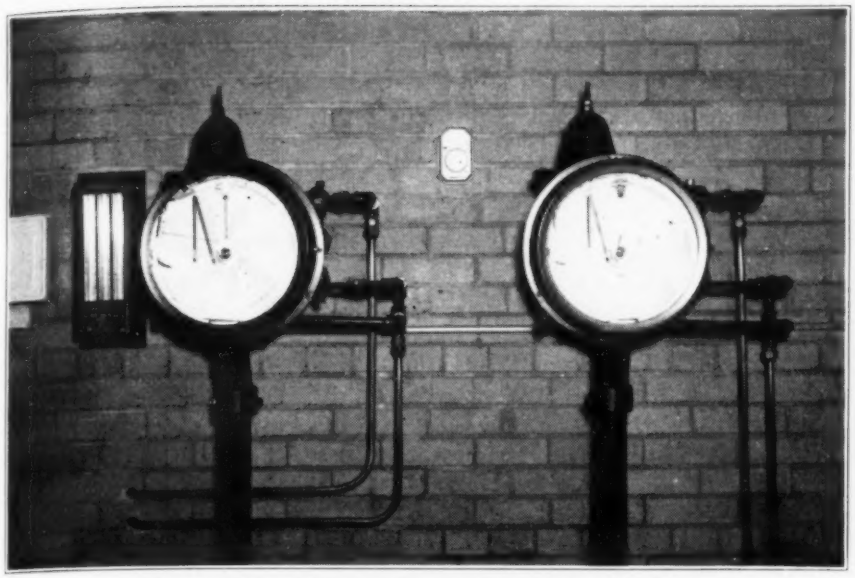


Fig. 3—Recording Instruments on Gas System

Always an operation aid are such instruments. These record gas pressures and volume of gas produced and volume wasted.

Table I
ANALYSES OF COMPOSITED DIGESTED SLUDGES
(Samples from Separate Heated Sludge Digesters in Connecticut)

Sample	Moisture %	Fixed Solids, %	Volatile Solids, %	Alkalinity (Total ppm.)	pH
1	92	46	54	3300	7.1
2	91	65	35	1000	6.7
3	96	40	60	2000	6.9
4	93	50	50	1800	6.8
5	91	49	51	3100	7.1
6	93	50	50	2500	7.0
7	87	68	32	1300	6.8
8	96	45	55	2400	6.9
9	90	46	54	2100	7.0
10	89	56	44	2900	7.0
11	87	59	41	4400	7.2
12	87	62	38	3000	—

displace the heavier solids. Theoretically the daily addition of raw volatile solids to a digester should not exceed 3 to 5 per cent of the volatile solids already present in the tank. In practice, most operators are compelled to make daily additions based on the raw solids accumulations from the treatment process units. Alkalinity, pH and volatile acid tests, previously mentioned, are operating guides to tank loadings where more than one digester is available.

Sludge should not be allowed to remain in secondary digesters for long periods of time, or it may become too heavy for removal. Occasional recirculation of bottom sludge in secondary tanks, during storage periods or initial filling, will help avoid this condition. The introduction of sludge at the periphery of such tanks aggravates this condition and it is the writer's belief that better results are secured by discharge of primary tank sludge near the tank's center at a point about half the tank depth or greater. The argument that discharge at the tank's center results in removal of some partially digested sludge is more theoretical than actual. The practice of drawing sludge slowly, and in reasonable amounts, is of far greater importance in holding back undigested material.

4. Tank temperatures have been increased in recent years. Some digesters in Connecticut have been operated at sludge temperatures of 95 to 100°F.; in others the winter temperature has been nearer 80 to 85°F. because poor tank insulation, inadequate heating facilities, or other factors, have prevented carrying higher temperatures. Higher temperatures promote digestion of scum and accelerate sludge digestion, both being desirable objectives. (See discussion on this point in "Sewage Treatment" by Imhoff & Fair, John Wiley & Sons, Inc., New York, p. 196.)

5. Sludge soundings were discussed in the article of this series devoted to "Imhoff Tanks." Such soundings or samplings are equally important in the operation of heated digesters. If sufficient sampling taps have been provided by the designer with a convenient sink outlet (described in article six of this series) a fairly true inventory of the digester's contents can be obtained by this means. Otherwise some type of depth sampler, such as was described and pictured in the section on "Imhoff Tanks" should be lowered through manholes in the tank cover. Operators should obtain an inventory of the digester's contents at intervals of one to two months. The findings can be tabulated against depth (recording depth of scum, supernatant liquor, and sludge) or plotted on a blueprint of the tank's cross-section. Symons has discussed sludge inventories as performed at Buffalo. Operators would do well to review his procedure[2]. Without periodic soundings, intelligent operation of digesters is not possible; yet many operators fail to make such inventories with the result that scum accumula-

(2)—*Sewage Works Engineering*, December, 1941, p. 641.

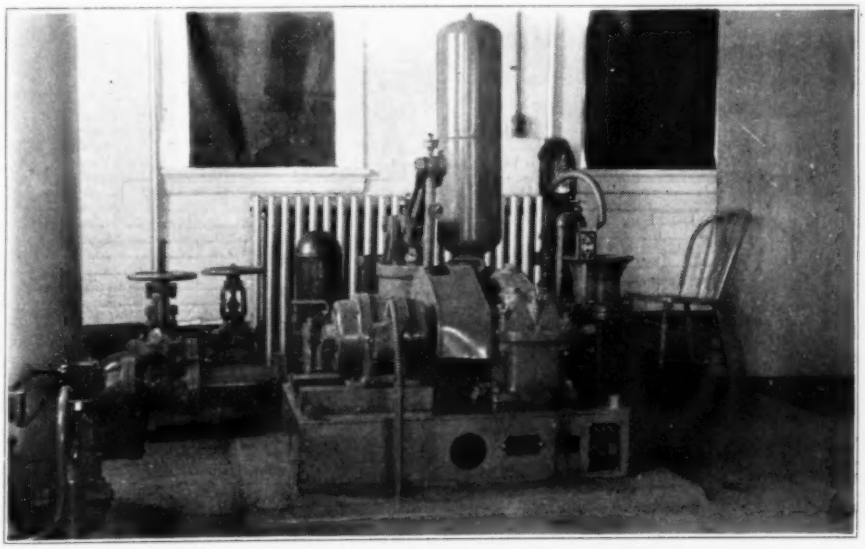


Fig. 4—A Modern Sludge Pumping Unit

On right is the sludge sampling device on the discharge side of pump.

tions may become excessively deep, sludge levels may grow too high, or so much sludge may be drawn from the digester that insufficient remains to maintain the proper balance between digested and fresh solids input.

(Author's Note: The control of scum and the handling of supernatant liquor from established digesters will be discussed separately below.)

Controlling Scum

When is scum of concern in the operation of digesters? First, when it becomes so matted and thick that it retards the escape of gas or overloads stirring equipment. Second, when it slowly but persistently increases in depth, with or without apparent digestion. Sometimes scum accumulations are the result of certain industrial wastes, particularly those of a greasy or fibrous nature. When scum, digested or undigested, continues to accumulate it must eventually be removed or the scum and sludge levels will meet and no supernatant liquor zone will remain. Most of the scum control measures have been discussed in previous articles in this series. Summarized, together with one or two additional controls, they include:

1. Use of water spray piping under tank covers.

2. Use of the slow stirring type of mechanical breaker.

3. Hosing with water or supernatant liquor through the cover manholes, with subsequent removal to vacuum filters, sludge drying beds, or lagoons through side wall supernatant overflow pipes.

4. Manual forking out of stringy or matted material from access manholes in the tank cover.

5. Fine screening of raw sewage prior to sedimentation if fibrous wastes entering the sewers are giving trouble. Pre-screening of fibrous wastes at the offending factory is desirable, too, with adequate supervision.

6. Better cover insulation.

7. Resting the digester, where possible.

8. Carrying a lower sludge level may have some effect due to the increased length of travel for gas-buoyed solids to the surface.

It should be emphasized that if the scum in a digester is fairly black, soft, homogeneous, has no offensive odor, and remains reasonably constant in depth, it should be considered a normal condition and need cause no concern.

Handling of Supernatant Overflow Liquor

A digester that is not overloaded and is properly operated will usually produce supernatant liquor of good quality. Analyses of typical digester overflow liquors are given in Table II. The *total* solids in the average overflow liquor should run 0.5% (5,000 ppm.) or under. A total solids content of 0.3% or under constitutes good liquor. When the total solids exceed 1%, the discharge would be more rightly termed, dilute "sludge."

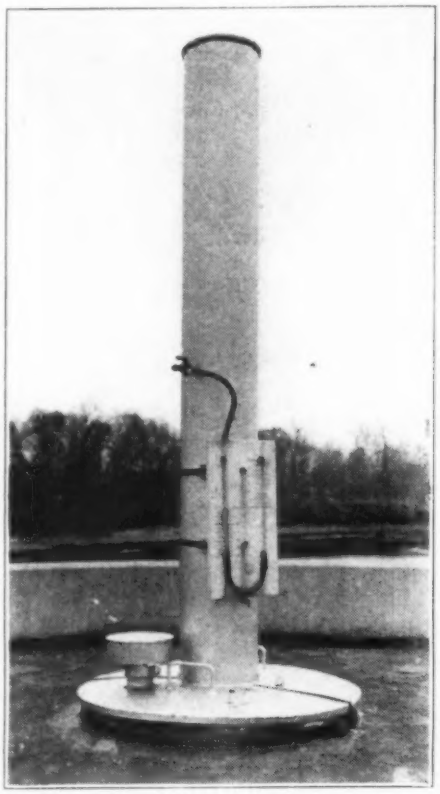


Fig. 5—Portable U-Gage For Measuring Gas Pressures

This one is in use at Milford, Conn.

The *suspended* solids in good overflow liquor will run about 1,000 ppm.; but 2,000 ppm. is more likely to be average for many digesters. When the liquor has more than 3,000 ppm. of suspended solids, it may adversely affect the settling tank effluent if returned to the raw sewage.

For small plants with limited laboratory equipment, a settling test on overflow liquor may be made by the use of a graduated cylinder. The procedure and results to be expected were described in the third article of this series under the heading "Unheated Digesters."

The following suggestions may prove helpful, when either the quality or quantity of digester overflow liquor is causing trouble:

1. Carry as low a sludge level as permissible and still maintain sufficient seed sludge.

2. Be sure scum depths are not excessive—i.e., not more than 3 to 4 feet.

3. Try a lower digester temperature if the tank is a heated unit operated alone or in parallel with other digesters. If the piping arrangement will permit switch to trial series operation if parallel operation has been practiced with difficulty.

4. Draw supernatant more slowly. (See the earlier discussion of "Design of Heated Digesters.")

5. With floating cover tanks, draw liquor after a period of quiescent settling; never immediately after pumping raw sludge, recirculating or drawing bottom sludge.

6. With fixed cover tanks, decrease the raw sludge pump speed so that the displacement of digester liquor will be at a lower rate.

7. If the tank has a number of supernatant liquor draw-off levels (and all digesters should), sample the entire tank depth frequently to determine the best drawing level.

8. Revise the raw sludge pumping schedule so that more concentrated raw sludge will be discharged to the digesters. This will greatly reduce the disturbance of the digester contents as well as the volume of overflow liquor. Visual observation of the character of the raw sludge and daily records of its volume are operators' "musts."

Table II

ANALYSES OF OVERFLOW OR SUPERNATANT LIQUORS

(Composite Samples from Separate Sludge Digestion Tanks in Connecticut)

Sample	Type of Digester	Total Solids (ppm.)	Suspended Solids (ppm.)	Total Alkalinity (ppm.)	pH
1	Heated, floating cover, normal load	4000	2200	2000	6.8
2	Heated, fixed cover, fixed overflow	4200	2700	—	7.0
3	Heated, fixed roof, rectangular	4400	3100	—	7.1
4	Unheated, open top secondary tank	1500	290	2100	7.3
5	Unheated, rectangular secondary tank	800	100	1600	7.2
6	Unheated primary, some overload	10,000	1300	3900*	7.2*
7	Heated, rectangular	1100	430	1800	6.8
8	Heated, floating cover	3000	—	1800	6.8
9	Heated, primary	1400	190	1200	6.9
10	Heated, primary	7000	5100	2100	7.0

*This tank regularly limed.

9. With a fixed position digester overflow, an improvement is often possible at small expense by building a wooden baffle or box around the discharge pipe, extended to a depth shown by experience to yield overflow liquor of good quality.

Safety Precautions

Operators should be familiar with the recommendations in Manual of Practice No. 1 on "Occupational Hazards in the Operation of Sewage Works."[3]

The following items are a brief summation of the most important safe practices:

1. Use a combustible-gas indicator or the soap solution test at regular intervals to check all sludge gas piping and appurtenances for leaks,. Leaks, although frequently of a minor nature, are very common in gas systems and if neglected may become serious. The odor of sludge gas cannot always be depended upon to detect its presence.

(3)—Published by the Federation of Sewage Works Associations, 325 Illinois Building, Champaign, Ill., for distribution to members at no cost. Available to non-members at 50 cents per copy.

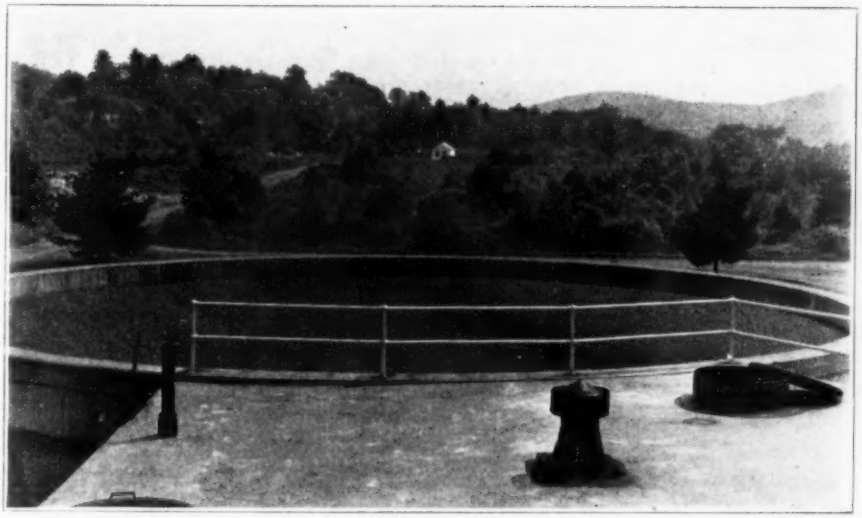


Fig. 7—Open-top Unheated Secondary Digester at Torrington, Conn.
With scum 9 inches thick, but soft and black, there have never been any objectionable odors. In reality it is floating digested sludge, beneath which is good quality supernatant liquor.

2. Always keep a digester filled to the overflow level or, if equipped with a floating cover, keep the cover floating. Partially filled digesters constitute a serious explosion hazard.

3. Maintain adequate ventilation in working galleries near sludge pumps, digesters, gas piping and the like.

4. When a digester is being emptied for repairs or inspection, permit no workmen to enter the tank until the atmosphere has been tested for the absence of noxious gases *or oxygen*

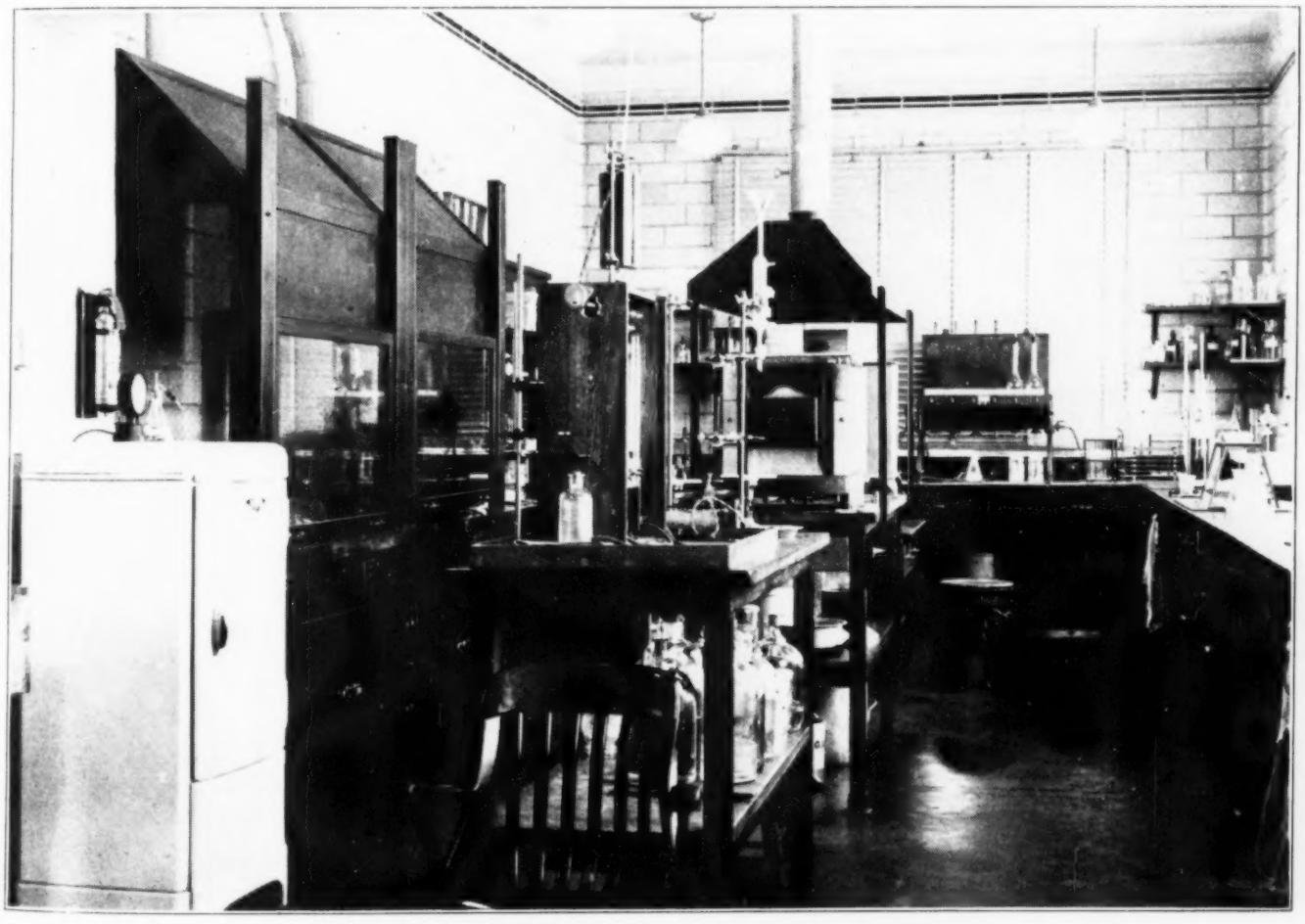


Fig. 6—A Well Planned and Equipped Laboratory
Such a laboratory as this at Hartford, Conn., is a boon in the control of sludge digestion processes.

deficiency. The importance of oxygen deficiency has too frequently been overlooked when entering sumps, pits, etc., in general Allow no smoking or open flames, and guard against sparks during digester emptying operations. All lighting equipment must be of the safety gas-proof type, and this applies to extension lights and flashlights. Workmen should enter the tank, *after testing the atmosphere,* with safety belts attached and at least two men on duty at the top. If the emptied digester still contains some scum and sludge, tests for noxious gases and oxygen deficiency should be repeated at intervals.

In the next and concluding article of this series the use and operation of sludge lagoons as a method of digestion will be discussed, together with concluding remarks on the various methods for the digestion of sewage solids already dealt with in previous articles.

Use of a non-sparking portable air blower, set up over a manhole in the tank's cover, is recommended. All manhole covers should be off. If noxious gases are present or an oxygen deficiency exists, which has not been corrected by ventilation, workmen should normally be excluded from the tank until a safe working atmosphere is obtained. To quote from the Sewage Works Federation Manual:

"Work that is progressing in flammable gas atmospheres is extremely hazardous and should never be attempted except by those thoroughly familiar with the dangers and fully equipped with the proper protective safety equipment."

Inasmuch as the Federation's Manual lists both the dangers that may be encountered and the proper protective equipment to use, the reader should consult this source for details.

Who Me?

A guide for improving human relations authored by Arthur O. England, has been published by the National Foremen's Institute, Inc., at Deep River, Conn.

Titled, "Who Me?" this pamphlet has been prepared as a brief, handy guide for all supervisors—division, department heads, and foremen for achieving better human relations.

Of pamphlet size, brief and to the point, and cleverly illustrated with cartoons, this booklet which was designed primarily for use in large industries, will be of interest to anyone who is the supervisor in water and sewage plants or for that matter, anyone who has to deal with people.

Single copies are obtainable from the National Foremen's Institute, at Deep River, Conn., for $.25 each. Copies in large quantities may be had at special prices.

Suggest Artificial Lakes To Guard Water Supply

"Water Resources of Southern Ill." prepared by the staff of the Ill. State Survey at Urbana, Ill. is a second in a series of booklets prepared at the request of citizens of Southern Ill. Cooperating in the State Geological Survey are the State National History Survey, the State Water Survey, Southern Ill. University and the University of Illinois.

The report discusses the needs for water and suggests that the Southern Ill. communities take steps to determine the general community water requirements, evaluate present water supply installations, obtain necessary services of consulting engineers and develop a water system master plan.

Of the three water sources, sand and gravel wells, rock wells, or surface lakes, reservoirs and streams, the latter group is the principal source of water in the southern counties. The booklet recommends that because of the shortage of water supplies for future development that all communities in the area consider the creation of artificial lakes, because the region favors their development. One of the booklet's five maps show the location of 109 potential lake sites.

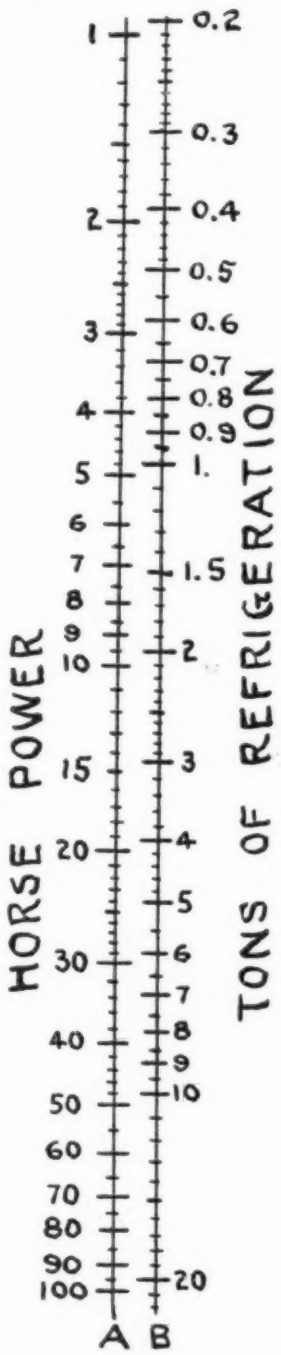
This approach to a problem in one section of the country may have an interest for other sections of similar topography and water resources. For persons interested the book is available by addressing a letter to the Joint Committee on Southern Ill., 205 David Kinley Hall, University of Ill., Urbana.

REFRIGERATION AND HORSE POWER*

Refrigeration and air conditioning are rapidly becoming commonplace, and there is a need for a chart showing the relationship between refrigeration and horse power?

The chart is based on theoretical values. A ton of ice represents 288,000 Btu. And since one Btu. is equal to 778 foot-pounds, and there are 33,000 foot-pounds in a horse power per minute, it is evident that the theoretical relationship can be readily determined. Thus the chart shows that one hp. is equivalent to 0.21 tons of refrigeration; or, 10 hp. is equivalent to 2.1 tons. In other words, with an overall refrigerating machine efficiency of 100 per cent a 10 hp. motor would produce 2.1 tons of ice in 24 hours. A 100 hp. motor would produce 21 tons of ice in 24 hours. And so on.

For example if you should want to know the theoretical equivalent of, say, 6 tons of refrigeration, you use the chart in this way: Find the 6 in column B and simply glance across to column A. It will be found that the answer is 29 hp.



*Contributed by W. F. Schaphorst, M. E., Newark, N.J.

CLEANING AIR DIFFUSER PLATES BY SANDBLASTING

by
JOHN R. LONGLEY

District Engineer
GREATER PEORIA SANITARY DISTRICT
PEORIA, ILL.

THE air diffuser system in the activated sludge sewage treatment works of the Greater Peoria Sanitary District was placed in operation in May, 1931. Despite the fact that the plant is located in an industrial section of the city of Peoria with immediate adjacent industries burning more than 1000 tons of bituminous coal daily, (and the resultant air pollution), the air diffuser plates as evidenced by their present length of use, have given good service. This service, however, has been made possible only by considerable periodical work on the plates to maintain satisfactory porosity.

To protect the diffuser plates the air is first filtered through two batteries of filters, a Midwest oil circulation impingement type filter followed by an American Airmat filter.

The air diffusers are 12x12x1½ in. Filtros plates of 12 to 16 cfm. rating grouted in concrete plate holders. The plates cannot be removed without breakage.

The air is supplied by a 13,600 cfm. gas-engine-driven Roots-Connersville Blower with the engine rated at 70 lb. mep. when the discharge air is at 8.25 psi. The engine can carry the blower at full rated speed with a blower discharge pressure of 8.8 psi. It is not considered good practice, however, to operate this unit continuously above 8.5 psi.

The Author

Diffuser Operation and Cleaning

During the early years of operation the rate of air discharge through the plates was in the order of 1.5 cfm. per plate. As the load on the plant increased the rate of discharge per plate increased until at the present time the rate is 2.4 cfm. per plate.

No difficulties with head loss through the diffusers were encountered during the first five years of operation. The blower discharge pressure was 6.9 psi. at 1.5 cfm. per plate when the plates were new. In the next five years cleaning of one of four batteries of plates with muriatic acid was undertaken three times to improve distribution of air rather than the need for overall lowering of blower discharge pressure.

In the spring of 1940 the blower discharge pressure reached 8.4 psi. and the rate per plate was 2.0 cfm. Three batteries of plates were cleaned by surface treatment with caustic soda followed by sulphuric acid. The blower discharge pressure dropped to 7.4 psi. but by the summer of 1943 the blower discharge pressure again rose to 8.5 psi. and all of the diffusers were cleaned by surface treatment with 3 per cent chromic acid. The blower discharge pressure dropped to 7.4 psi. and it was not until the spring of 1945 that the air diffusers again required cleaning.

In May 1945 the pressure rose sharply to above 9.0 psi. and all of the diffusers were treated with two applications of chromic acid. The blower discharge pressure dropped to 8.3 psi. and by August of that year it had again risen to 8.6 psi. All of the above pressure readings were observed at a rate of 2.0 cfm. per plate. The average quantity of air passed by each plate in its 14 years of use was about eleven million cubic feet and it appeared that the diffusers had come to the end of their usefulness.

Cleaning by Sandblasting

Since new air diffusers were not on hand for immediate replacement, it was considered desirable to try sandblasting the tops of the plates as practiced in Milwaukee, Wis. An inspection of plates removed from the holders indicated that while some material

Fig. 1. Boat for Guiding Sandblast Nozzle

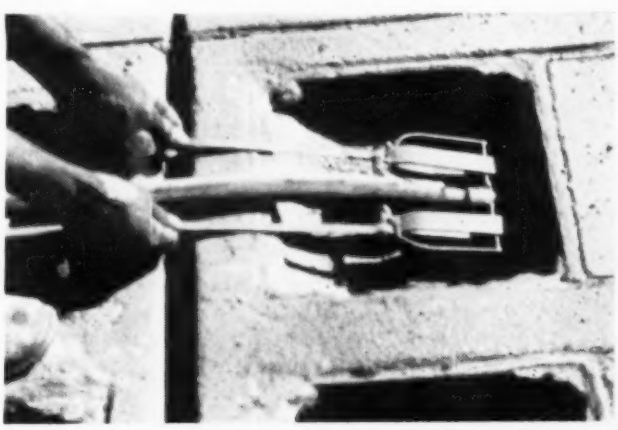


Fig. 2. Sandblast Boat Being Fed Into Opening

(One man operates tapes to oscillate nozzle, another man draws nozzle, back and forth)

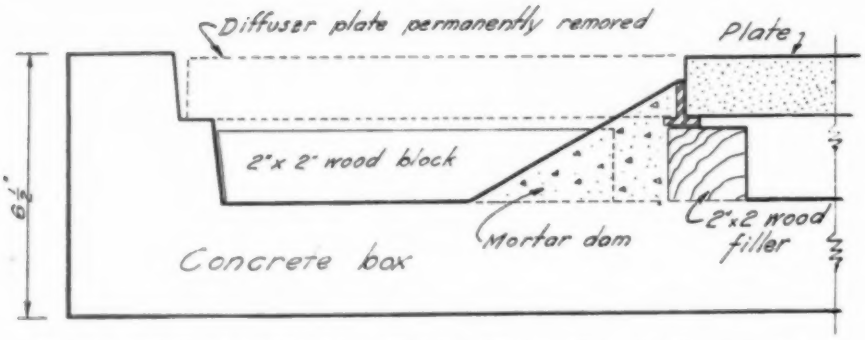


Fig. 3. Method of Blocking Holder Where Plate Is Removed for Sanding Operation

was deposited in the tops of the plate, the plate bottom was covered by a tight layer of black material much like carbon in appearance. It was apparent that if sandblasting was to be applied the greatest benefit would result from the treatment of the underside of the plate.

Experiments were conducted with various devices by which the bottoms could be sandblasted. Fig. 1 indicates the device finally used. The opening under the plates was a channel 10¾ in. wide and 9 ft.-6 in. long with a height to the bottom of the plate of 1¾ in. A metal boat to guide the nozzle in this space was devised. The nozzle was inclined at an angle of 30° with the horizontal, and hinged tapes were provided at each end of the boat for oscillating the nozzle from side to side at the same time that the boat was pulled from one end of the channel to the other.

The sandblast boat as pictured in Fig. 1, consisted of a frame of 1 x ⅛ in. flat mild steel supporting the sandblast nozzle. A 12 ft. length of ¾ in. water hose was connected to a ½ in. pipe nipple which was connected in turn through couplings and bushings to a ¼ in. extra heavy nipple which acted as the sand discharge nozzle. The bushing was drilled and threaded at an angle of 30° to receive the ¼ in. extra heavy nipple. The latter nipples wore out rather rapidly, one nipple being used for approximately every 150 plates. The remainder of the pipe fittings did not wear excessively and required replacement for the sandblasting of approximately 2000 diffusers.

The end plate opposite to the air inlet in each channel was removed and the sandblast boat was pushed into the space below the plates through the opening, as in Fig. 2. The sandblast was applied and the boat was moved to the end of the row of plates and returned three times. While the boat was being pulled back the tapes were subjected to a reciprocating motion which caused the nozzle to swing from side to side in order to allow the sand to impinge on the entire underside area of the plate.

Before starting the cleaning operation, air was blown through the plates until the plates were thoroughly dried. If a plate is wet the sandblasting will be ineffective. After the sandblasting of the under side of the plates was completed, the sand which was deposited in the air channel was blown out with air from the Connersville Blower. This was accomplished by placing a 1½ in. rubber hose in the openings of each of the channels as plugs and removing one temporary plug at a time. The large volume of air passing through the channel removed all of the sand.

The openings in the ends of the channel were then permanently plugged with 2 x 2 wood blocks backed with concrete mortar. This is shown in Fig. 3. After the mortar had set, air was blown through the plates and the tops of the plates were sandblasted with the conventional sandblast nozzle. The tops of the plates were sandblasted in such a manner that all of the soft material was removed. After the sandblasting, with the air still passing through the plates, the sand remaining on the plates was swept off with a broom, or blown off with the high pressure air.

The sandblasting equipment consisted of a 100 cfm. air compressor capable of delivering air at 100 psi. and a 300 lb. sand container with appurtenant hose and fittings. The sand used was "Flintshot No. 2." One cu. ft. of sand cleaned the tops and bottoms of about 20 diffusers.

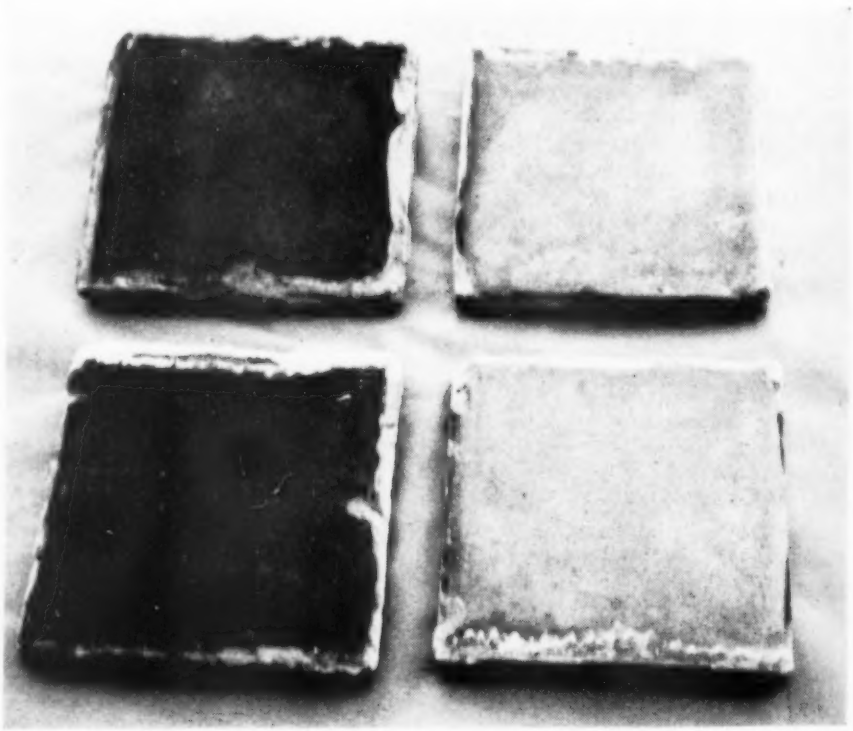


Fig. 4. Plate Bottoms Before and After Sandblasting

Effectiveness of Sandblasting

Fig. 4 is a view showing the appearance of the bottoms of the plates before and after sandblasting.

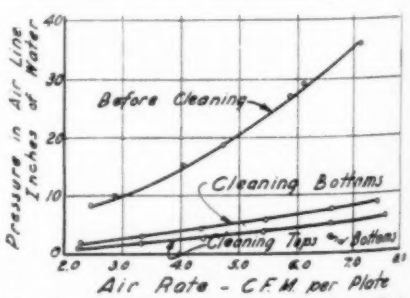


Fig. 5. Comparison of Cleaning Bottoms Only, and Both Bottoms and Tops—1945

(This was a test with dry plates)

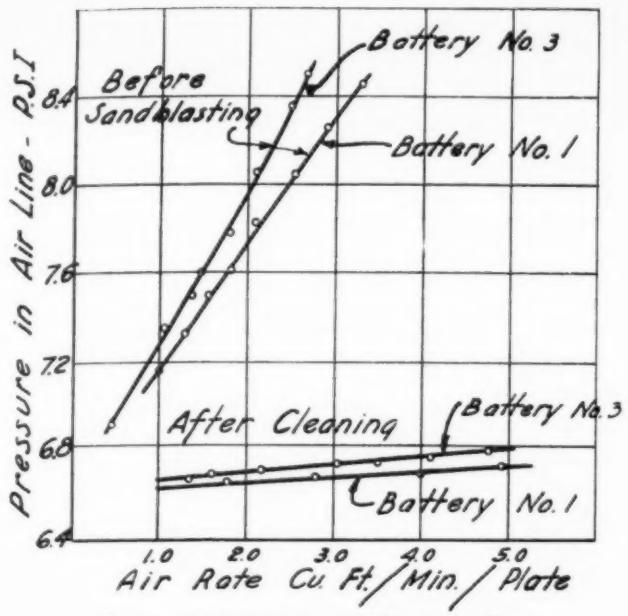


Fig. 6. Effectiveness of Cleaning Air Diffusers Under Operating Conditions—1945

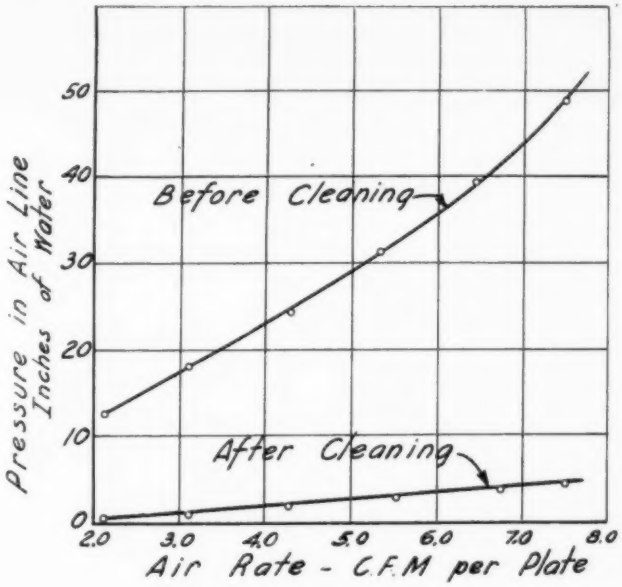


Fig 7. Effectiveness of Sandblasting of Air Diffusers—1947

(Test was made on dry plates)

Fig. 5 indicates the effect of cleaning the bottom of the plates only and subsequently cleaning the diffuser tops. As was expected the great change in head loss was observed by cleaning the plate bottoms. Cleaning the tops of the plates resulted in a worthwhile improvement but in itself would not result in a sufficient lowering of the head loss to make the operation worth while. This test was made with the plates dry and was merely used to determine the comparative effectiveness of the sandblasting operation.

Fig. 6 indicates the effectiveness of the sandblasting operation under actual plant operating conditions. The immediate effect seemed to restore the plates to a loss of head corresponding to new plates but this condition did not persist for a very long period. The pressure loss rapidly increased to 7.6 psi. and remained at this level until the summer of 1946. During the summer months air temperature and humidity rose to levels which caused water to deposit in the plates, thus increasing the head loss through the diffusers. It was possible, however, to operate through 1946 without cleaning. In the summer of 1947, the blower discharge pressure again rose to 8.6 psi. and the cleaning by sandblasting was repeated. The effect of this sandblasting is indicated in Fig. 7. These curves are for head loss through the diffusers with the plates dry before and after cleaning.

Fig. 8 represents the comparative conditions of operation after the cleanings of 1945 and 1947. It is apparent that the second cleaning was not as effective as the first. Six months after cleaning, however, the pressure was only 7.7 psi. as compared to 7.6 psi. six months after the first cleaning.

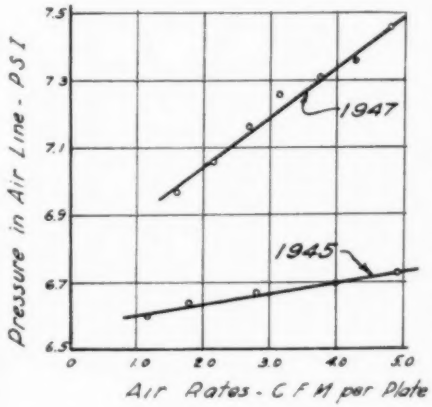


Fig. 8. Comparison of Sandblasting Effects on Air Diffusers—1945 and 1947

(Under normal plant operating conditions)

Cost of Sandblasting Air Diffusers

The sandblasting work was carried out by a local contractor. Some of the work, such as removal of end plates and cleanup, was done by Sanitary District Employees. The total cost of the work in 1945 was 35.9 cents per plate for the plates remaining in service, eight-ninths of the original installation, the end plates in each box having been removed. The cost of the work in 1947 was 35.8 cents per plate. While labor rates were higher in 1947 than in 1945 no time was lost in experimental work in the second operation. The cost of cleaning the tops of the plates only would be about ten cents per plate.

FLORIDA VIEWS STREAM POLLUTION

How the State of Florida views "Stream Pollution" is amply described in the October, 1947 issue of Florida Health Notes, published by the Florida State Board of Health. This particular issue, written by David B. Lee, Chief Sanitary Engineer, and John C. Patterson, Sanitary Engineer, Florida Department of Health, is a down-to-earth discussion of Stream Pollution, its causes, and its remedies. Maps and pictures make the bulletin of considerable use to engineers and health department personnel throughout the State.

We bring it to your attention at this time because we believe that other states and sanitary engineers may find Mr. Lee's approach helpful in selling stream pollution abatement within a state.

For copies of this bulletin, write to David B. Lee, Chief San. Engr., Department of Health, Jacksonville, Fla.

ODOR AND TASTE CONTROL AS INFLUENCED BY CONSUMERS' PIPES

by
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Consulting Technologist
LOS ANGELES, CALIF.

THE battle to prevent objectionable odor and taste in public water supplies began some forty years ago when Moore and Kellerman introduced the use of copper sulphate to control plankton growths in reservoirs. It aimed to cure taste troubles by preventing the growth of organisms which caused some of them. Sulphate of copper is still employed; but, with the exception of rare instances, its use in practice is confined to open reservoirs. Then, the campaign moved to the treatment plant when it was found that chlorine, either alone or in combination with ammonia, would greatly lessen certain odors. Next, activated carbon entered the field and between chlorine and carbon it became possible to deliver to the distribution system water which was virtually free from odor and taste, even though the raw water coming to the plant was of poor quality in this respect.

The Author

Subsequently it was found that good water could spoil in the mains with the development of worse tastes than had been previously observed. In consequence, the battle had then to be carried to the distribution system.

The Experience of Beverly Hills

The City of Beverly Hills, California, using water from wells which were rich in hydrogen sulphide, was the scene of an experience that clearly illustrates this phase of the struggle to furnish water free from odor or taste. An architecturally beautiful plant was erected on one of the most important boulevards, in the heart of the residential section, where aeration and chlorination were depended upon to remove all trace of sulphides. Lime softening was added; and, of course, long retention followed by rapid sand filters and recarbonation. The effluent was pronounced "perfect" by everybody, and Beverly Hills settled down to enjoy the achievement.

But the victory over odor and taste was short-lived except within the shadow of the plant, where residual chlorine still persisted. Soon hydrogen sulphide was present in the far reaches of the distribution grid and it spread inward toward the plant until the entire system became afflicted with more aggravated odors than ever before. In those days little attention was paid to bacteria in water pipes provided coliforms were absent, and nobody thought about them here until investigation brought out the story of what had happened and pointed the way to victory. The old water, before introduction of softening and filtration, had a high content of organic matter and the usual population of soil and water bacteria which it brought to the distribution system found a comfortable home there, attaching themselves to the walls as thick gelatinous slimes. Their presence before the new plant was built had caused no recognized trouble, for as scavengers they were performing their natural task of removing organic matter.

When the treated water entered the system it was practically devoid of dissolved oxygen, an element which is as essential to bacteria as to humans. But some bacteria are quite as resourceful as the human aviator who carries tanks of oxygen with him when he invades the stratosphere where the gas is too scarce to support life. Bacteria in environments where oxygen is absent play the role of manufacturing chemists and pry loose the essential gas from some handy oxygen-rich substance, such as sulphates or nitrates, the former being abundant in most natural waters.

At Beverly Hills sulphates were reduced in this manner, and of course, the by-product of this operation was hydrogen sulphide. The extent to which it appeared in the mains is best illustrated by the experience of one

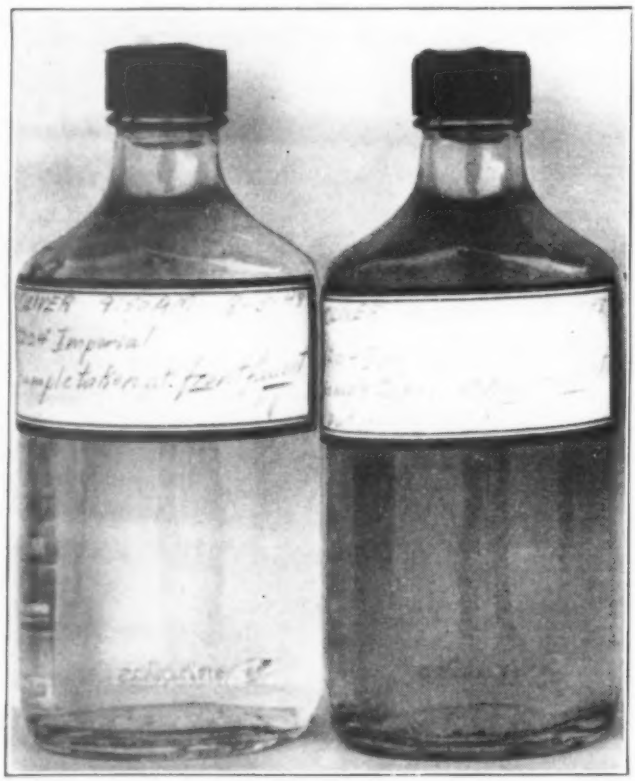

Fig. 1—Water Samples from the Imperial Drive Residence in Glendale, Calif.

The bottle on the left contains water drawn from the service line entering the residence. It is crystal clear. The bottle on the right contains cold water drawn from a faucet in the rear of the residence. The turbidity and discoloration was traced to slime growths within the house piping system. (Photo by Courtesy of the Glendale Water Dept.)

woman who was particularly insistent in her complaint. She had just had her house redecorated and had paid an extra price to have the bathroom painted in pure white lead paint. She told the Water Department inspectors: "After the bathroom was finished I took one bath, and before I could get out of the tub those beautiful white walls were a dirty brown-black! Come and look at them." She was right, and she was no happier when told that had she used cheaper zinc-white paint or titanium oxide paint the walls would not have been ruined.

Corrective Measures Applied

To correct the condition, chlorination at the plant was stepped up as high as feasible and systematic cleaning of the pipes with heavy doses of chlorine was done progressively from the plant to the periphery of the system. This work was done between midnight and early morning. A main was cut out of service, filled with water containing 50 parts per million of chlorine, which was allowed to stand in the pipe for two hours, after which the line was thoroughly flushed and returned to service. Following this, chlorination at the treatment plant made it possible to carry strong residuals throughout the system, and odor and taste troubles are now seldom encountered.

The lesson learned here was that the program to prevent odor and taste production has to be extended to the mains and carried all the way to the consumers who are farthest from the plant. Water is a more favorable medium to support life than is air, and wherever water occurs living organisms will flourish unless active measures are taken to prevent their development. Where they develop they will make trouble: QED, take steps to prevent them from developing in water pipes.

Realizing that practically all odors and tastes which develop in the mains are caused by bacteria, the more progressive cities are using chlorine to destroy and remove existing growths, after which they continuously carry sufficient chlorine residuals throughout the distribution system to prevent recurrent growths. Since corrosion and tuberculation of water pipes is in many instances caused by bacteria, the program to prevent bacterial growths may well pay an additional dividend in the checking of corrosion or tuberculation.

Fig. 2—Control Storage Water Heater, San Diego, Calif.

The cutaway section reveals interior of hot water tank receiving untreated San Diego water and operated continuously at 150° F. The dark growths of destructive bacterial slimes caused failure of this tank after 19 months of service.

The Glendale Case

The lessons learned at Beverly Hills were later found very helpful in Glendale, California, a compact city of 100,000 population adjoining Los Angeles. Glendale uses well and infiltration gallery water in a completely closed system. An infestation of the iron-loving bacteria Crenothrix became established throughout the distribution grid, causing endless complaints of "dirty water" as well as bad taste, and it was decided about two years ago to attempt its control with chlorine. In the hope of creating as little inconvenience to consumers as possible the dosage employed at first was only one part per million as water left the plant. As an additional deterrent to Crenothrix, sodium carbonate was added in order to reduce free carbon dioxide and raise the pH to about 8.0. At the outset residual chlorine readings dropped to zero only a short distance from the plant, but as the weeks passed the front of chlorine-bearing water was found to slowly advance, indicating chlorine saturation of the slime growths and organic deposits in the pipes. Then, the Crenothrix began to slough and flushing had to be resorted to for its removal.

Now, after two years of methodical work, the mains are free of growths and complaints of dirty water and "algae" (the common name for Crenothrix in Glendale) have dropped to the vanishing point, but odor and taste troubles in various parts of the city still occur. Upon investigation of these complaints it is almost invariably found that the water is "bad" in one house but not at other houses on the same block, showing that the trouble occurs in the house pipes.

Fig. 3—Parallel Storage Water Heater, San Diego, Calif.

This tank was operated continuously at 150° F. in parallel with the control tank. The only difference was that this tank received chlorinated San Diego water. The treatment, although not entirely effective, reduced the slime growths by 50% or more. It is estimated that life of tank was extended 40% or more. This test run is being repeated with better chlorine control.

A typical case is that of a consumer in Imperial Drive, whose complaints of dirty water have persisted over several weeks. Her next door neighbors on each side report "no trouble," and water drawn direct from the main is clear and palatable. In an effort to find the trouble three samples were taken at the complainant's house each day for over a week. One sample, taken at the front of the house near the meter, represented water entering her house pipes. The other two, taken at points farthest removed from the meter, were depended upon to reveal any effects of the house pipes. One of these represented hot water from the storage heater. All samples taken nearest the meter were clear and free from odor throughout the sampling period. Of the samples from the house fixtures those taken from the hot water faucets were the worst, but there were great differences here from day to day, some samples being very bad, and some almost good. Samples from the end of the house lines contained more or less suspended matter, also varying considerably among themselves, but never as good as water coming from the main.

Microscopic examination showed the suspended matter to consist of bacterial slimes, stained with iron oxide. The hot water samples contained much more iron oxide, but even here bacterial slimes were abundant.

Bacterial Slimes in Hot Water Heaters

In this connection it is pertinent to mention that in some experimental studies of the biological phase of water heater corrosion, which are being carried out at San Diego, it has been found that bacteria grow abundantly in water held at 140° to 150° Fahrenheit, forming slime colonies on the heater walls. Sterile micro-slips have been inserted into the tanks through special fittings designed for the purpose, and left for a few hours, after which they were removed for study. After an exposure of 24 hours in the heater the slips were covered with coalescent colonies, but with shorter exposures isolated colonies and even small groups of single bacteria could be found, and pure cultures of these organisms have been grown in an incubator operated at 130° Fahrenheit, its upper limit. From this work it is definitely known that bacteria do grow abundantly in water heaters.

In support of the above statement, the two accompanying photographs (courtesy of the San Diego Water Department) illustrate bacterial growths and the destruction to which they give rise in storage water heaters. Fig. 2 is the control heater cut longitudinally, showing the growths in untreated San Diego water in a heater operated continuously at 150°F. The dark areas are bacterial slimes impregnated with iron oxide. Corrosion here has given rise to the usual tubercles. Fig. 3 shows a tank which was operated at the same temperature and for the same length of time, but supplied with chlorinated water containing on the average 2.5 parts per million chlorine as the water went to the tank. Residual chlorine in the tank effluent often dropped to less than 1 part per million. Here again, the dark areas show bacterial slimes stained with iron oxide and with accompanying tubercles. It was estimated by the San Diego officials that slime growths had been reduced slightly more than 50 per cent by the chlorine treatment. These tanks were both operated on the same schedule with five gallons of water drawn off every hour by automatic controls. Unfortunately, control of the hypochloride solution which was used to dose the second tank was not effective and residuals dropped too low to give the amount of protection which had been anticipated. The control tank failed at 19 months of constant service, but the tank receiving chlorinated water was still in good condition and probably could have been operated for another year before failure. A second set of experiments is now underway in which we have better chlorine control than in the first setup.

"Battle of House Pipes" Not Yet Won

It is not at all surprising that bacteria should inhabit house pipes; or, that growing there, they should affect the quality of water. In the first place the pipes are small in cross-section, and slimes lining the pipes come more intimately into contact with the body of the water than in pipes of larger diameter. Water in house pipes is warm and stagnant much of the time, perhaps as much as 75 per cent, and so has an opportunity to absorb a larger amount of the by-products of bacterial activity which give rise to odor and taste. Maximum taste occurs in water drawn in the morning after having remained in the pipe over night.

The water works profession has at its command today methods to effectively control odor and taste in reservoirs, in the treatment plant, and even in the distribution system, but it has not yet won the "Battle of the House Pipes." Can it ever be won? Those pipes are private property, and it might be construed to be the owner's duty to keep them clean, as much as it is his task and expense to maintain clean and bright the pitchers and glasses in which water goes to the table.

If house pipes were clean at the start, and if water in the mains carried a chlorine residual of one part per million, perhaps the chlorine passing the meter at such times as water is being drawn in the house might inhibit growths, but where slimes are already established such treatment will accomplish little or nothing.

This problem is real, but it does not become apparent until odor and taste and dirty water have been eliminated from the mains; then house piping troubles are brought out in high relief against the excellent quality of water coming to the meter.

ALLEGHENY COUNTY SANITARY AUTHORITY REPORT

The *"Report on the Proposed Collection and Treatment Municipal Sewage and Industrial Wastes"* by the Allegheny County Sanitary Authority, was completed at the end of January, and now has become available in published form.

In brief, the report proposes that all of the service areas, including 102 communities, should be delivered to a central point on the Ohio River for pre-aeration, primary treatment and chlorination, at a single plant, except for 2 isolated areas. It is proposed that the principle interceptors be laid under the river bed for the most part. The report sets up an estimate of construction cost of some $82,000,000, and an estimate of approximately $5,000,000 a year for operation and debt service. A proposed sewer rental system based on water consumption is included.

There are certain legal restrictions at the present time which prevent this program from being carried out. The report proposes that these restrictions be lifted.

Copies of the report may be obtained by writing to John F. Laboon, Chairman, Allegheny County Sanitary Authority, 502 City County Building, Pittsburgh 19, Pa.

THE CHEMISTRY OF WATER TREATMENT

Part III. Stabilization

by
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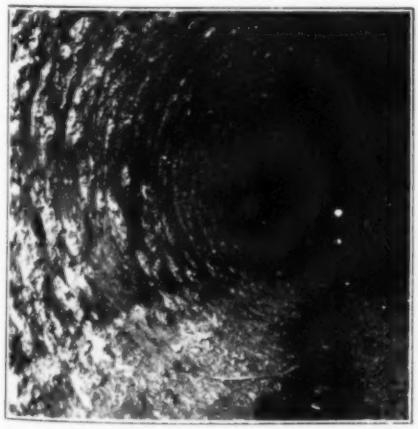
THE increased emphasis which has been placed in recent years upon the stabilization of water supplies results from the realization on the part of superintendents of treatment plants that their responsibility for the quality of the treated water extends beyond the filters; that they must turn out a finished water that will neither incrust nor corrode the distribution system and that will reach the ultimate consumer essentially as it leaves the plant.

The basic processes of coagulation and softening which have been discussed in parts I and II of this series do not, as a rule, result in treated waters which will meet this criterion. Waters following coagulation may often be quite soft and the pH value so low that unless further treatment is provided excessive corrosion would result. On the other hand, water softened by the lime-soda process will also be soft, but will have a high pH value and will be more or less supersaturated with calcium carbonate.

It becomes of interest, therefore, to review the methods which have been



Example of Tuberculation in 48-in. Steel Pipe

developed to render waters non-incrusting, or non-corrosive as the case may be. Although such methods vary widely with respect to the theory involved, materials used and methods of application, they are usually collectively called "Stabilization".

The Author

Fundamental Nature of Corrosion

While there is still much to be learned about the fundamental nature of corrosion in spite of the very voluminous literature now available, the most commonly held conception is that it is an electro-chemical process whereby a metal loses electrons and passes into solution in an area which thereby becomes anodic. The following equations have been employed to represent some of the reactions which take place:

1. $Fe = Fe^{++} + 2e$
2. $Fe + 2H^{+} = Fe^{++} + H_2$
3. $H_2 + 1/2\ O_2 = H_2O$
4. $1/2\ O_2 + H_2O + 2e = 2(OH)^{-}$

The first reaction shows iron entering solution with the loss of two electrons. The area within which the reaction takes place thereby becomes positive and acts as an anode.

The second reaction shows metallic iron reacting with hydrogen ions and passing into solution with the liberation of hydrogen gas which plates out on the metallic surface. If this hydrogen film could be maintained in place, protection against further corrosion would be afforded. Such a system is said to be polarized.

The third reaction shows how hydrogen may be oxidized by the dissolved oxygen present in the water.

The fourth reaction shows the mechanism whereby the two electrons lost in reaction (1) may be absorbed by dissolved oxygen and water molecules with the formation of negatively charged hydroxide ions. The dissolved oxygen in equation (3) is termed a de-polarizer and great emphasis has been placed for many years on the important part played by dissolved oxygen in corrosion since it is present to a greater or lesser degree in all aerated supplies. However, any oxidizing agent may, like oxygen, act as a de-polarizer and absorb the electrons, thus promoting corrosion. Among those which may be present in water supplies are free chlorine and nitrate ion. Many examples of extremely active corrosion under completely anaerobic conditions have been traced to one or the other of these agents.

In the case of anaerobic corrosion, the iron which passes into solution by either reaction (1) or (2) above is oxidized and precipitated as ferric hydroxide, thus producing the tuberculation familiar to the water works man. In the case of anaerobic corrosion, however, no tubercules are formed, the iron remaining in solution, imparting a most unpleasant taste to the water and producing staining of fixtures by its oxidation when it comes in contact with air.

Insoluble Calcium Carbonate Incrustation

(This deposit of calcium carbonate from an unstabilized lime-softened water reduced the pipe size from 10-in. to 5-5/16-in. Recarbonation was adopted to prevent recurrence after the main was cleaned.)

Basis of Corrosion Control

A consideration of reactions (1) and (2) given above, immediately indicates two general methods which may be used to protect against corrosion. The first of these is to provide a protective coating so that the water does not come in direct contact with the metallic surface. These coatings are of two types, those mechanically applied and those formed upon contact with the water. Mechanically applied coatings include cement lining, applied either when the pipe is manufactured or in place after cleaning, bituminous coatings, likewise applied during manufacture or in place after cleaning, or a combination of the two. Coatings formed upon contact with water include phosphate coatings, silicate coatings, and calcium carbonate coatings.

Phosphate coatings are formed in place by feeding a nominal dosage of one of the several available molecularly dehydrated phosphates (sometimes called glassy phosphates). The dosage to be employed depends upon several factors, the most important being the pH and the total hardness of the water, but in any case the protection afforded appears to depend upon the formation of a protective film on the surface of the metal.

Silicate films may be formed in a similar manner by adding sodium silicate, the dosage required being considerably higher than for the glassy phosphates. This method of corrosion prevention has not been as widely employed as has the use of the glassy phosphates. The method appears to work best in hot water systems.

The formation of a protective film of calcium carbonate brings us to the second general method for corrosion control, namely, elevation of the pH by the addition of an alkali. The alkalis used for this purpose include lime, soda ash, and caustic soda. If the water is sufficiently soft so that the additional hardness introduced by the addition of lime is not objectionable, then lime is always employed because of its lower cost. If, on the other hand, it is not desired to introduce additional hardness then soda ash or sodium carbonate may be used, the choice depending upon the relative cost and the buffer capacity of the waters being treated.

Whichever is used, the result will be the precipitation of calcium carbonate on the surface of the pipe at a definite pH value, this value varying with each individual water and depending upon a number of factors which are to be discussed later. If the pH value is raised too far above the critical value, then the coating formed will become so thick as to decrease the carrying capacity of the pipe, but if the amount of alkali added is insufficient to reach this critical pH value, the water may retain some of its corrosive properties. The question which immediately confronts the water works operator, therefore, is, "what must be the pH value of my final effluent in order that it may neither be corrosive, nor incrusting?" To the chemist, this question becomes, "how may I determine the pH at which a given water is exactly in equilibrium with calcium carbonate?" Before answering the questions, we must digress for a moment to consider the stabilization of lime softened water.

TABLE FOR CALCULATION OF ALKALINITIES

TITRATION	HYDROXIDE ION AS $CaCO_3$	CARBONATE ION AS $CaCO_3$	BICARBONATE ION AS $CaCO_3$
P = 0	0	0	T
P < M	0	2 P	M-P
P = M	0	T	0
P > M	P-M	2 M	0
M = 0	T	0	0

P = PHENOLPHTHALEIN TITRATION; T = TOTAL TITRATION; M = T-P.

Table for Calculation of Alkalinities

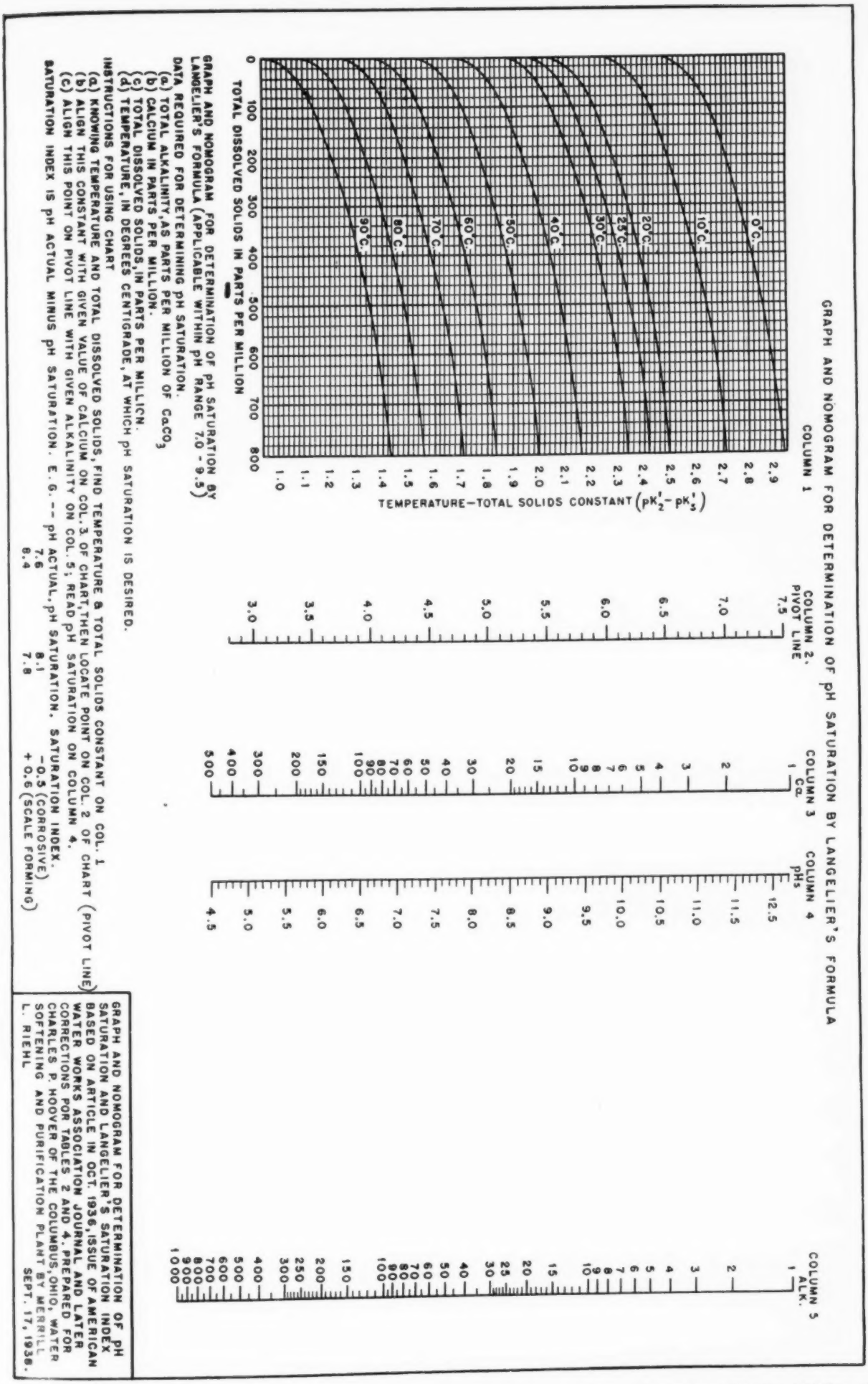
Stabilization of Lime Softened Water

As has been stated, water softened with lime or lime and soda ash will have a hardness dependent upon the dosage of chemicals added and the solubility of the precipitated sludge in the water being softened. Since the first factor may be controlled by the operator, the second becomes the critical or limiting factor. The solubility of calcium carbonate in distilled water at ordinary temperatures is very small, only 12 parts per million.

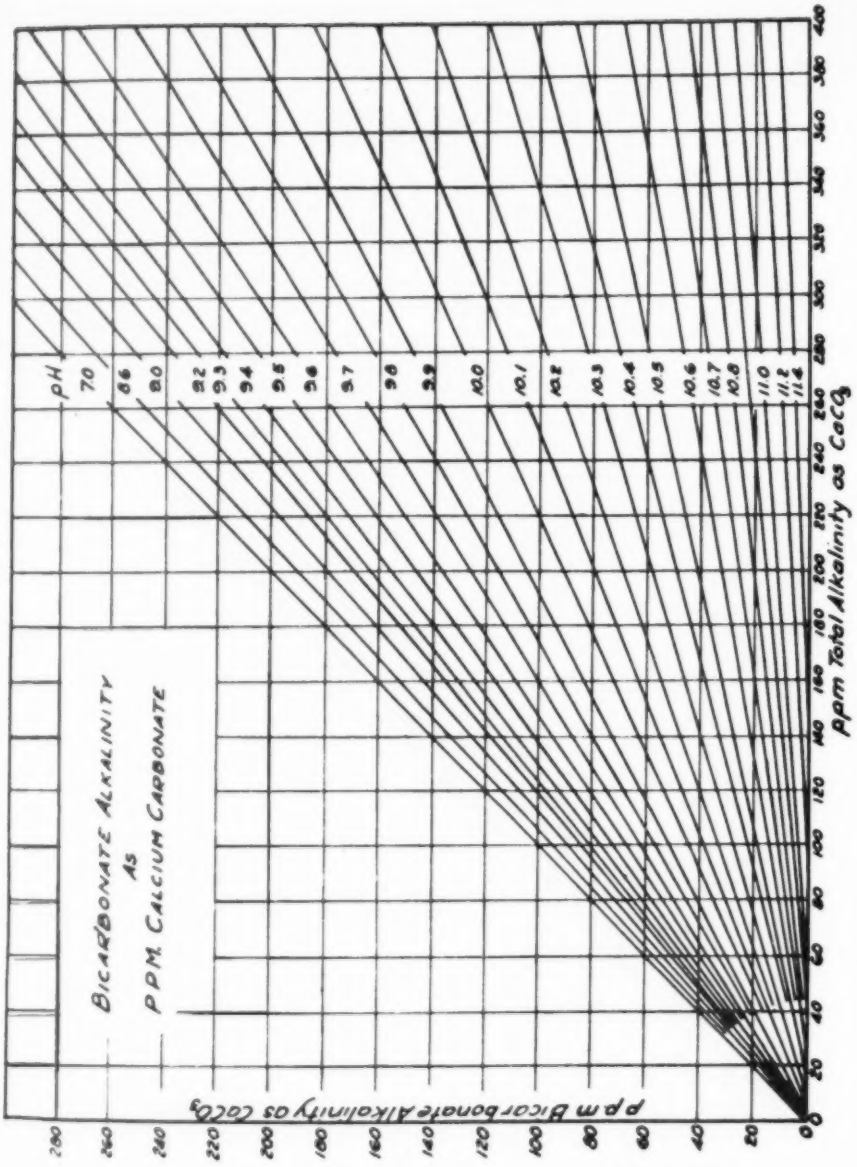
Every operator of a softening plant is familiar with his inability to obtain a water of this final alkalinity. This is due to the phenomenon of supersaturation which may be defined as solubility in excess of the equilibrium value. It may be illustrated by a simple experiment. In a beaker is placed a handful of sodium thiosulphate crystals, about 50 ml of distilled water is added and the mixture raised almost to the boiling point. As the crystals all dissolve more are added until excess crystals remain. The hot solution is now filtered through a coarse filter paper into a flask which is stoppered and allowed to cool slowly in contact with the air. No precipitation of crystals will take place although the solubility of the salt is many times greater at room temperature than near the boiling point. If now, one removes the stopper and adds to the clear solution a few tiny crystals of the material, the mass will set to a solid within a matter of seconds and the flask may be inverted without loss of liquid content. This is an extreme example, but the results of a slight degree of supersaturation over a long period of time may be equally startling and costly.

In an accompanying photograph is shown a section of pipe through which has been passed unstabilized water softened by the lime soda process. These calcium carbonate coatings may attain a thickness of two to three inches and a weight of several hundred pounds per section of pipe. If such water is passed without stabilization through the filters, the filter medium will be incrusted in a like manner and the size of the grains of sand or coal will increase to the point where the filter becomes relatively ineffective and cementing and solidification may take place.

Two general methods of stabilization of such water have been developed. The first consists in the use of the same molecularly dehydrated phosphates which are employed for corrosion control. Indeed, these materials were first developed and advanced for the prevention of the precipitation of calcium carbonate and their use as agents to prevent corrosion was a later development. The exact mechanism by which this remarkable effect is produced is not clear, but that they are extremely effective has been well established. Furthermore, the dosage required to prevent the precipitation of calcium


GRAPH AND NOMOGRAM FOR DETERMINATION OF pH SATURATION BY LANGELIER'S FORMULA
COLUMN 1
TOTAL DISSOLVED SOLIDS IN PARTS PER MILLION
TEMPERATURE—TOTAL SOLIDS CONSTANT $(pK_2' - pK_s')$
0°C.
10°C.
20°C.
25°C.
30°C.
40°C.
50°C.
60°C.
70°C.
80°C.
90°C.
COLUMN 2. PIVOT LINE
COLUMN 3 Ca.
COLUMN 4 pHs
COLUMN 5 ALK.
GRAPH AND NOMOGRAM FOR DETERMINATION OF pH SATURATION BY LANGELIER'S FORMULA (APPLICABLE WITHIN pH RANGE 7.0 - 9.5)
DATA REQUIRED FOR DETERMINING pH SATURATION.
(a) TOTAL ALKALINITY, AS PARTS PER MILLION OF $CaCO_3$
(b) CALCIUM IN PARTS PER MILLION.
(c) TOTAL DISSOLVED SOLIDS, IN PARTS PER MILLION.
(d) TEMPERATURE, IN DEGREES CENTIGRADE, AT WHICH pH SATURATION IS DESIRED.
INSTRUCTIONS FOR USING CHART
(a) KNOWING TEMPERATURE AND TOTAL DISSOLVED SOLIDS, FIND TEMPERATURE & TOTAL SOLIDS CONSTANT ON COL. 1
(b) ALIGN THIS CONSTANT WITH GIVEN VALUE OF CALCIUM ON COL. 3 OF CHART, THEN LOCATE POINT ON COL. 2 OF CHART (PIVOT LINE)
(c) ALIGN THIS POINT ON PIVOT LINE WITH GIVEN ALKALINITY ON COL. 5; READ pH SATURATION ON COLUMN 4.
SATURATION INDEX IS pH ACTUAL MINUS pH SATURATION. E.G. -- pH ACTUAL, pH SATURATION. SATURATION INDEX.
7.6 8.1 -0.5 (CORROSIVE)
8.4 7.8 +0.6 (SCALE FORMING)
GRAPH AND NOMOGRAM FOR DETERMINATION OF pH SATURATION AND LANGELIER'S SATURATION INDEX BASED ON ARTICLE IN OCT. 1936, ISSUE OF AMERICAN WATER WORKS ASSOCIATION JOURNAL AND LATER CORRECTIONS FOR TABLES 2 AND 4. PREPARED FOR CHARLES P. HOOVER OF THE COLUMBUS, OHIO, WATER SOFTENING AND PURIFICATION PLANT BY MERRILL L. RIEHL SEPT. 17, 1938.

Graph and Nomogram for Determination of pH Saturation by Langelier's Formula [5]



Graph for Determining Bicarbonate Alkalinity Where pH and Total Alkalinity Are Known (After Moore[6])

(Relations between pH, carbon dioxide, normal carbonate and hydroxide, and total alkalinity are given in original paper[6].)

carbonate is usually substantially less than that required to prevent corrosion.

The second method of stabilizing water softened with lime or lime-soda has been used for many years and is termed "Recarbonation". This process consists in passing carbon dioxide gas through the softened water to convert a part of the calcium carbonate to the more soluble calcium bicarbonate, thus preventing its precipitation on the filter medium or in the mains.

We now find ourselves back to the same sixty-four dollar question which we faced in our discussion of corrosion control, namely, "what should be the pH of the stabilized water so that it will neither be incrusting nor corrosive?" The answer to this question has been the subject of constant study on the part of water chemists since about 1912, and the last fifteen years have witnessed a number of important and fundamental papers. It is our purpose here to briefly review some of these papers, summarize the specific contributions made by each, and indicate how the information presented may be used by the water works operator or chemist. References are given only to papers which have appeared in publications of the waterworks profession, where they may be consulted as desired.

Some Early Approaches

In 1912 Tillmans and his co-workers began a series of studies which extended over a period of twenty years and during which they developed the well known "Marble Test" for measuring stability. This test still remains the best laboratory method for controlling stabilization. It is the basis of the Enslow Continuous Stability Indicator which is now widely used. An even more elaborate modification of the same test is used by Hartung of the St. Louis County Water Co., and has been described by him[10].

The principle of the test itself is quite simple. The water in question is held in contact with calcium carbonate for a considerable length of time and the alkalinity determined before and after contact. If there is a decrease in alkalinity the water is supersaturated and incrustation would be the result of its use without further treatment. If there is an increase in alkalinity, the water has the property to dissolve a protective calcium carbonate coating and corrosion might result. If there is no change in alkalinity, the water is considered to be stable.

It is highly desirable, however, to have available a means of calculating this so-called "pH of saturation". Bayliss about 1930[12] published a curve showing the solubility of calcium carbonate in water of varying alkalinities and varying pH values. This curve was widely used by plant operators for several years. Its limitations, however, soon became evident. In our discussion of coagulation in Part I, we learned that every ion present in the water has some effect on the process. Similarly, physico-chemical studies have revealed the fact that the solubility of a salt is affected by every other ion present in the solution. Methods have been developed to calculate the so-called "ionic strength" of a water and by its use to correct the solubility of calcium carbonate for the presence of other ions present in the water.

Determination of the Forms of Alkalinity

When we speak of the forms of alkalinity in a given water, what do we mean? There are two entirely different answers to that question, depending upon the use to which the answer is to be put. The operator controlling his dosages of lime and soda ash in a softening plant wishes to know if he is correctly dosing his water. For that purpose, he uses the well-known differential titration with 0.02 N sulfuric acid employing both phenolphthalein and methyl orange as indicators, and then he calculates hydroxide, normal carbonate and bicarbonate ions in terms of calcium carbonate by the use of the table given in *Standard Methods*[13] or by the simplified table presented herewith.

If for example, as pointed out by Dye, he prepares a solution containing

42.4 mg. of pure sodium carbonate in one liter of distilled water and titrates the 100 ml. sample with 0.02 N sulfuric acid using phenolphthalein and methyl orange as indicators, he will obtain a "P" titration of 2.0 ml., a "T" titration of 4.0 ml., and a "M" titration (by difference) of 2.0 ml. Using the table, he will calculate all of the alkalinity as normal carbonate, which is exactly what he added. Had the "P" titration exceeded the "M" titration, calculated as above, the sodium carbonate would have contained some sodium hydroxide and had his "P" titration been less than his "M" titration, his sodium carbonate would have contained some sodium bicarbonate. Under no circumstances, however, will his titration indicate the simultaneous presence of hydroxide, normal carbonate, and bicarbonate.

When the pH of the solution is determined, however, it is found to be 10.3 and a simple calculation indicates that the actual hydroxide ion concentration present in solution at that pH value, expressed in terms of calcium carbonate, is 10.0 parts per million. This hydroxide ion could only have resulted from the hydrolysis of the carbonate ion by the following equation:

$$CO_3^{=} + H_2O = HCO_3^{-} + OH^{-}$$

Since the equation indicates that for each hydroxide ion formed a bicarbonate ion is likewise formed, the alkalinity actually present in the solution is in three forms, 10.0 ppm. as hydroxide, 20.0 ppm. as normal carbonate and 10.0 ppm. as bicarbonate, an answer which it is impossible to obtain by the method of titration.

We arrive then at the conclusion that whereas determination of alkalinity by titration is and will continue to be a most useful tool for determining chemical dosages, it cannot and should not be used to determine the forms of alkalinity present in a finished water when stabilization is the end to be obtained. For this purpose, one of the new approaches must be used. In 1933, McKinney advanced a method for calculating the forms of alkalinity in terms of pH and free and combined carbon dioxide. His method also required a complete mineral analysis of the water. In 1936, Langelier[4] advanced a new method for calculating concentrations of bicarbonate and normal carbonate ions, and a method of calculating what he termed the "saturation pH" or pH_s. His method assumed the following basic reaction for the reversible coating of a pipe with calcium carbonate:

$$CaCO_3 + H^{+} = Ca^{++} + HCO_3^{-}$$

In the presence of the calcium carbonate film, its concentration may be considered to be a constant and the following equation results from the application of the mass law:

$$\frac{[Ca^{++}]\ [HCO_3^{-}]}{[H^{+}]} = K$$

Rearranging the terms and expressing each as a negative logarithm, we obtain:

$$pH_s = pCa + pHCO_3 - pK$$

If the pH of the water is less than about 9.0 he shows that $pHCO_3$ will be approximately equal to pAlk. He further demonstrates that pK is equal to the difference between two known constants, pK_2 the second dissociation constant of carbonic acid and pK_s the solubility product constant for calcium carbonate. The equation then becomes:

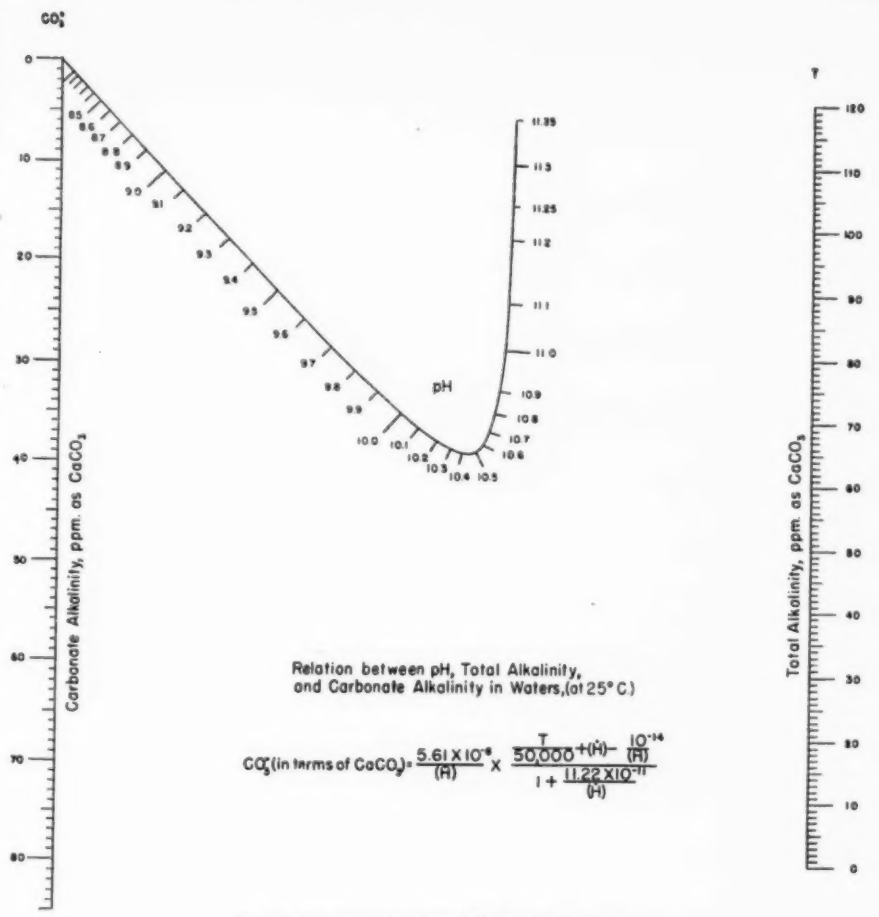
$$pHs = (pK_2 - pKs) + pCa + pAlk.$$

He further defines Saturation Index as $pH - pH_s$.

At the suggestion of Charles P. Hoover, Riehl[5] prepared and published a nomogram for the rapid and convenient determination of pH saturation using the Langelier equation. (See the accompanying Graph and Nomogram for Determination of pH Saturation by Langelier Formula.) Langelier suggested that similar equations might be derived for calculating free carbon dioxide and hydroxide ion and these equations were included in DeMartini's paper[6]. The basic objection to the use of both sets of equations lies in the fact that all concentrations are expressed either in equivalents or mols per liter. Moore[7] re-calculated these equations in such a form that the ionic concentrations are given in terms of parts per million as calcium carbonate. His equations are those which appear in the 9th Ed. of *Standard Methods*.[3] They may be more conveniently employed, however, by use of the curves which he presents in his paper.

One of his curves, to be used in determining that portion of total alkalinity present as bicarbonate, is shown herewith.

Dye[8] prepared and published nomographs which greatly simplified the


$CO_3^{=}$
Carbonate Alkalinity, ppm. as $CaCO_3$
pH
Total Alkalinity, ppm. as $CaCO_3$
Relation between pH, Total Alkalinity, and Carbonate Alkalinity in Waters, (at 25° C.)
$CO_3^{=}$ (in terms of $CaCO_3$) = $\frac{5.61 \times 10^{-6}}{(H)} \times \frac{T}{50,000 + (H) - \frac{10^{-14}}{(H)}} \times \frac{1}{1 + \frac{11.22 \times 10^{-11}}{(H)}}$

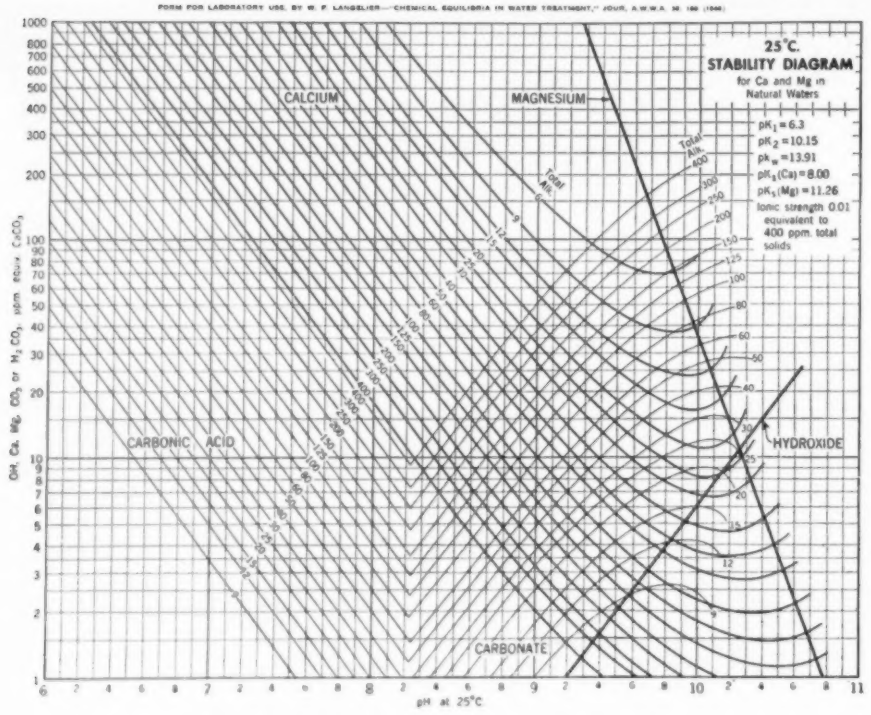
Based on Moore's Equation: Jour. A.W.W.A., 31: 51 (1939)

Chart 2

Dye Nomograph Showing Relation Between pH, Total Alkalinity and Carbonate Alkalinity [8]

(Relations between total alkalinity and pH, carbon dioxide and bicarbonate are given in the original paper[8].)

To use this nomogram, locate the value of total alkalinity on the right hand square and the pH of the water on the curved middle line. Lay a straight edge across these two values and the carbonate alkalinity, in ppm. as $CaCO_3$ may be read on the left hand square.



Stability Diagram—After Langelier [11]

This diagram may be used without salinity correction for natural waters from about 200 to 1000 ppm. of total solids. It furnishes a direct reading of pH_s which is applicable without correction at higher pH levels. It also gives the corresponding value of pH_s for magnesium.

determination of the forms of alkalinity. They are likewise based on Moore's equations and give ionic concentrations in terms of parts per million calcium carbonate. One of Dye's nomograms, to be used in determining that portion of the total alkalinity present as normal carbonate, is shown herewith. Larson and Buswell[9] reviewed Langelier's paper and suggest slightly different values for two of the constants used by him. Ryznar[10] reviewed Langelier's work and suggested that the saturation index is not always a true measure of the behavior of a given water and that a better measure is to be obtained by calculating its "stability index" which he defines as $2pH_s$—pH, the pH_s referring to that obtained by the use of the Langelier equation. Ryznar presents a table in which the behavior of some thirty-six waters are reviewed and shows that waters with identical pH_s values have stability indexes which may be quite different. He concludes that water having a stability index of less than 6 may usually be expected to form a calcium carbonate coating whereas the corrosive property of the water may be expected to increase as the stability index exceeds 7. Langelier's[11] most recent paper refines his equations and includes a consideration of equilibria as they pertain to magnesium hydroxide.

Langelier's stability diagram for calcium and magnesium in natural waters at 25°C. is presented herewith.

Simplest Approach

Confronted with all of the papers, charts, and nomographs which have been briefly mentioned above and examples of some of which are presented, what is the simplest approach for the average water works operator in order to determine the forms of alkalinity in a given water, and the pH at which his water should be maintained in order that it shall neither be corrosive nor incrust his distribution system?

Careful inspection of the equations of either Langelier or Moore indicates that their solution is both complicated and time-consuming. It is evident therefore, that the use of the charts and nomographs is to be preferred. An inspection of Moore's charts, one of which is shown herewith, indicates that for fairly high values of alkalinity their use will yield accurate values for the ions desired. For waters of low alkalinity, however, the numerous curves on the chart converge so closely that it is almost impossible to make accurate readings.

The Dye nomographs, on the other hand, are perhaps even easier to use, but, like the Moore curves, it is difficult to read accurate values when the alkalinity is less than 30 parts per million. For waters having alkalinities of 30 or below, it is therefore best to calculate values for the different forms by use of the Moore equations if accurate results are desired.

Without question, the simplest method of determining the pH of saturation of a given water is by use of the Riehl nomograph of the Langelier equation, which is shown herewith. It should be clearly understood, however, that the value so obtained is not necessarily the exact value to be maintained but a reasonably close approximation thereof. The pH of saturation is to be regarded as an approximate measure of a directional tendency and in actual use it should be supplemented by frequent observations both in the laboratory and in the field.

In view of the data presented by Ryznar, it would seem well also for the operator to compare the pH_s of Langelier and the stability index of Ryznar in order to ascertain which of the two is the more reliable guide to the behavior of his particular water. As mentioned earlier in this paper, the Marble Test, or some variation thereof, carefully made on water with several hours of contact time allowed before titration, represents a most valuable method of laboratory control. When, in addition, frequent observations are made of the condition of the distribution system at convenient locations provided for this purpose, the operator may know that he is delivering to his consumers water of the highest possible quality.

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OPERATION OF SMALL WATER FILTRATION PLANTS

Part VII—Taste and Odor Control

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THE FUNCTION of a water purification plant is to produce a water which is satisfactory in every respect to the consumer. This not only means a water free from visible turbidity and color but one also free from taste and odor. A water which is satisfactory in every respect, should also be free from hardness, iron, free carbon dioxide, manganese, etc. In some instances it has been necessary to change the source of supply in order to furnish the consumers with a satisfactory water, in others, additions to an existing plant and additional equipment have been installed to provide means for proper treatment. When considering a new source of supply careful consideration should be given to the type of plant as well as equipment necessary to properly treat the water so that the end product will be at all times acceptable to the consumers. Some years ago when taste and odor occurred in a water supply, it did not receive the attention it does today. It might have been a condition of short duration and the attitude was that it would clear up in a short time and the consumer would just have to put up with it.

Tastes and odors in water supply may result from the growth and death of algae or weeds, or from dissolved gases or industrial wastes. The cause of each particular taste or odor may require study before the solution to the problem is found.

Algae

Algae troubles received considerable attention and study, not only in classifying those which would produce taste and odor but in producing a means of controlling their growth and elimination.

There are a number of publications which enumerate and show pictorially the organisms which will produce taste and odor as well as the quantity of copper sulfate required to kill them. Their number and classification can only be determined by means of microscopic examinations of samples of the water. The technic of making

The Author

microscopic examinations is fully explained in most of the standard works on water analyses and with a little help from one familiar with this work the operator can learn to make the examinations in a relatively short time.

Control of algae growth is the best means of *preventing* tastes and odors in a water supply. Control of algae growths in a reservoir or lake is generally accomplished by the use of copper sulfate. The copper sulfate is distributed by dragging burlap sacks containing the crystals through the surface water in a pattern which will cover the entire surface of the water to be treated. The quantity required to kill any particular species of algae is known, so that by calculating the quantity of water to be treated, the total amount of copper sulfate to be distributed can easily be determined. The copper sulfate may also be sprayed over the water as a fine powder or as a solution.

Algae growths in small ponds or reservoirs can also be prevented by the use of an activated carbon "blackout" blanket sprayed over the surface of the water or by a chlorine blanket at the surface. These are all preventive measures.

Dissolved Gases

Aeration has taken care of the problem of dissolved gases to a great extent, as well as reducing other tastes and odors. Aeration in general is only applicable to certain tastes and odors which can be easily removed by this method. One of the later applications of aeration for the reduction of tastes and odors is at Nitro, W.Va., where aeration is accomplished under an average pressure of 55 psi. Tests were made with pressures between 55 and 110 psi. with progressively better results as the pressure was increased. Here again the taste and odor is reduced so that the application of reasonable amounts of activated carbon will eliminate the residual and produce an acceptable water.

Industrial Wastes

Tastes and odors from industrial wastes are so varied and of so many different types that each almost becomes a problem in itself. There is no empirical rule to follow, except the application of known methods for the elimination of tastes and odors, the experience of others who have the same or similar conditions or just having to work out a method which will apply to the particular problem.

Corrective Treatment

Once tastes and odors appear in water supplies, it is up to the operator to correct the trouble. In addition to aeration as a corrective treatment the operator has available the following materials: Activated carbon, chlorine, chlorine dioxide, ozone, and chlorine with ammonia. A "cure-all" does not seem to have been found up to the present time, but the writer is of the opinion that any of the above, alone or in combination have been of great benefit to the water works operator in keeping tastes and odors at a minimum.

Manufacturers of chlorinating equipment as well as those supplying chemicals are always glad to furnish all information they have and help in any reasonable way to eliminate taste and odor. The operator may not have the equipment required for the job at hand but there are usually some means available whereby he can use some accessible material or equipment until

more satisfactory material or equipment can be purchased.

Where taste and odor troubles are known to occur every effort should be made to provide the operator with equipment and materials to combat it as without these he is helpless and is blamed by the consumers for furnishing an unsatisfactory water, whereas, given the tools with which to work, he at least can make an effort to solve the trouble and usually do some good.

Chlorine alone many times will eliminate tastes and odors when using free residual chlorination. This can be tried on a laboratory scale and literature explaining this method can be obtained from Wallace & Tiernan Co., Inc., which has done much in developing this method with highly successful results. If the laboratory tests indicate the effectiveness of this method then it should be put into use on a plant scale, purchasing additional equipment if necessary to provide the chlorine capacity required. Chlorine and ammonia in combination has been found effective in some instances based on the reaction of chlorine with ammonia thus forming chloramines, its reaction being with the ammonia rather than with taste producing organic matter.

Activated carbon is generally applied by means of dry chemical feeders and is introduced into the water as a suspension of the carbon in water. The point of application depends on conditions. It may be more effective if fed into the water as it enters the settling basins and producing a "blanket" on the surface which would inhibit any algae growths which might occur in the basins or for quick results fed to the filters direct, to form a film on the sand surface. The activated carbon actually adsorbs the taste and odor producing substances and removes them from the water.

Chlorine dioxide, which is a more recent method for taste and odor removal than the chlorine and chlorine and ammonia methods, seems to hold promise of effective results in this field. Chlorine dioxide is produced by the reaction between chlorine and sodium chlorite, both combined in solution form and the resulting solution containing chlorine dioxide is fed into the water to be treated. Chlorine dioxide has about 2½ more oxidizing capacity than chlorine alone. Chlorine and sodium chlorite are usually combined in a weight ratio of 1:2 or 1:1.

The use of ozone for the elimination of taste and odor seems to offer considerable promise but is somewhat expensive and while it may not reduce it to the point desired it will reduce many tastes and odors and/or change their characteristics sufficiently so that further treatment with activated carbon will furnish an acceptable water.

Taste and Odor Control

Taste and odor control can be carried out by the old hit or miss method and missing more times than hitting but careful control is much better. In a water supply subject to this trouble the operator must be vigilant at all times. He must know the condition of his raw water and filtered water at all times. The consumer will surely complain when there is a noticeable taste or odor in the tap water and it is one of the functions of the operator to keep it from reaching the tap in the consumers' residence or place of business. The development of the threshold odor test provides the means for the operator to keep check on conditions of the water. It is not a difficult test to make and provides a measure of the odor intensity which is represented by a number. These tests made on the raw and tap waters at least once each day keep him informed as to the odor characteristics and intensity. In this way he places himself in a much better position to combat a taste and odor condition which may arise than as though he allows it to become noticeable before attempting to do anything about it.

The *Taste and Odor Control Journal* shows how East Chicago developed a continuous odor detector and states in part "The raw water for treatment is passed through a flume wherein it is aerated continuously and strongly. Above the flume they have suspended a large steel funnel shaped somewhat like a large megaphone. The advantage of the funnel design is obviously that it takes the air from a rather large area and concentrates it into a small area at the point where the operators smell it." The above supplements regular threshold odor determinations. There is no doubt that the above arrangement is of considerable help at this plant and demonstrates the ingenuity of the chief operator to seek additional help in taste and odor detection.

"Taste and Odor Control in Water Purification," a book issued by the Industrial Chemical Sales Division, West Virginia Pulp and Paper Co., is an excellent resumé of the subject and it is recommended that those who have troubles from taste and odor obtain a copy of this work. It contains much useful information and is presented in a manner that will be especially useful to the small plant operator.

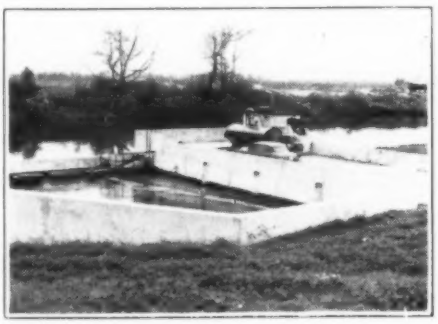
Operators should avail themselves of all information possible on this subject and apply this information to the solution of their own taste and odor problems.

OIL SEPARATORS EFFECTIVE AT YPSILANTI

Gale Oil interceptors and separators installed at the Ypsilanti Township Sewage Treatment Works at Willow Run, Mich., have been found both profitable and effective in eliminating oil from the stream.

According to a report by N. Herda, Sup't. of Utilities of the Ypsilanti Township, formerly the Willow Run Bomber Plant treatment works, during the month of May 1948, 12,720 gallons of waste oil were removed from the Gale oil separators and sold to a waste oil service company.

The local waste oil pickup company, which also operates a road oiling service, collects the oil in their truck at the treatment works. The price paid is from two to four cents per gallon and



during the month of May the total income was $292. In addition, 2,200 gallons of the waste oil were used for laying dust on the township roads.

The accompanying photograph shows the installation.

Silting of Reservoirs In Ohio

Bulletin No. 17 of the Department of Public Works Ohio Water Resources Board is titled *"Sedimentation Of Reservoirs In Ohio."*

The report, prepared by Earl E. Sanderson, contains information on the rate at which sediment accumulates and thereby reduces the available storage in surface water reservoirs in the state of Ohio. The bulletin also has data, photographs, and graphs to show how the sedimentation rate is determined.

A copy of this bulletin may be obtained by addressing a request to C. V. Youngquist, Chief Engr., Ohio State Dept. of Public Works, Columbus, Ohio.

PIPE BENDING CHART*

This chart will be found useful for determining the average radius of bend that should be given to common forms of pipe bends, numbers 1, 2, 3, and 4, as shown at the right, column E.

Also, knowing the radius of bend, the size of pipe, and the form of bend, column D gives expansion allowance of that bend.

For example a 5 in. pipe was bent to a radius of 40 inches, the bend being a common U-bend as shown by No. 2 in column E. What expansion may be allowed?

The dotted line drawn across the chart shows how the chart is used. Run a straight line through the figure 5, column A, and the 40, column B, and locate the intersection with column C. Then from the point of intersection run over to the mark in column E opposite the figure 2 and the intersection through column D gives the answer as 1.5 in. expansion allowance.

If the size of pipe were the same, 5 inches, the average radius 40 inches and the bend were a "No. 4" bend, the expansion allowance would be 3.7 inches. If the bend were a "No. 1" bend the expansion allowance would be 0.75 in.

Similarly if the expansion allowance is already known, if the form of bend is known, and if the size of pipe is known, the average radius to which the bend should be made may be determined. In other words, knowing any three of the four factors given in columns A, B, D and E the fourth or unknown factor is easily determined by following the method as explained above.

The chart is based upon these rules:

For Bend No. 1—Square the average radius of bend in inches and multiply by 0.0026 and then divide by the outside diameter of the pipe in inches.

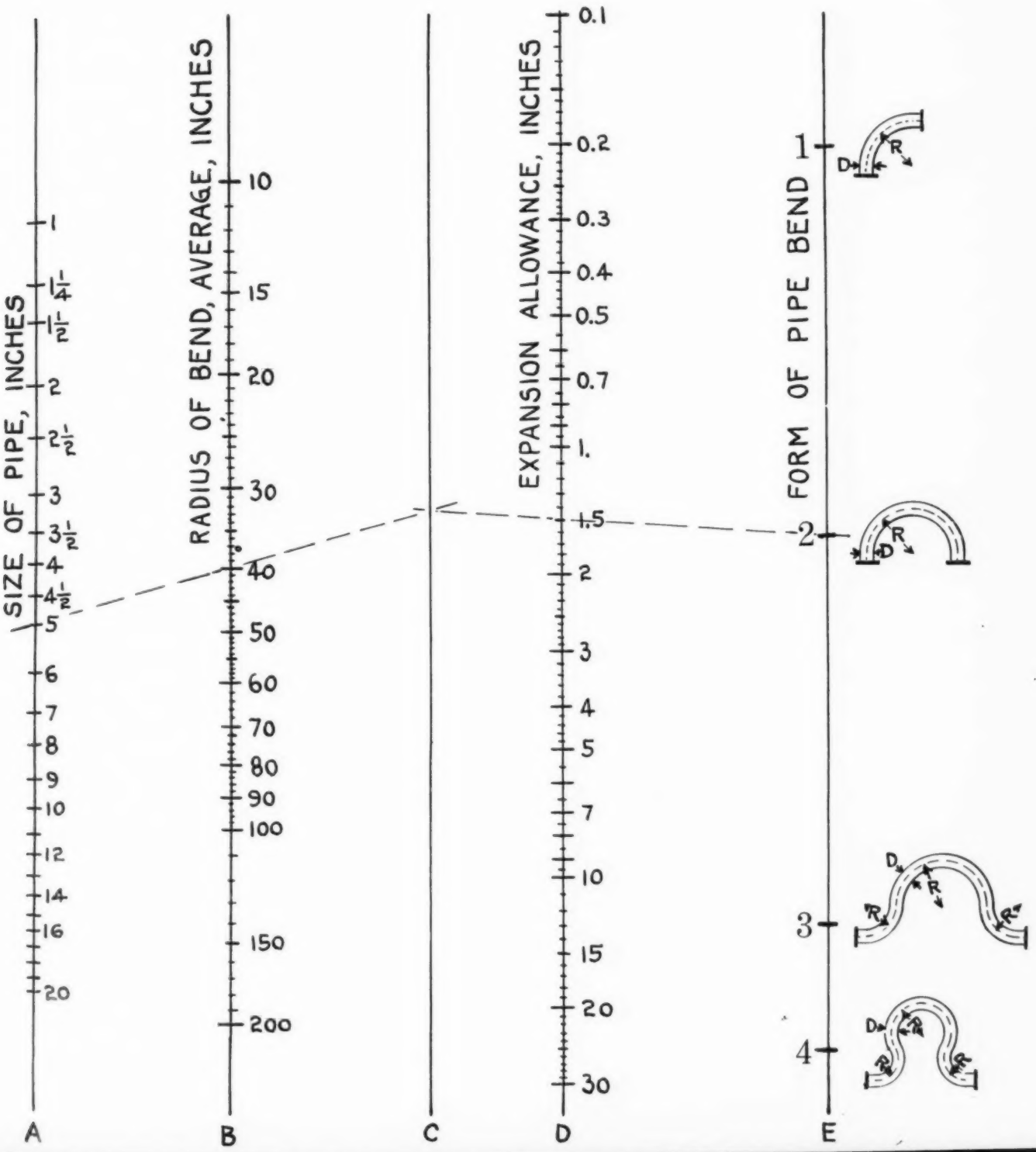
Bend No. 2—Same as No. 1 but multiply by 0.0052.

Bend No. 3—Same as No. 1 but multiply by 0.0104.

Bend No. 4—Same as No. 1 but multiply by 0.013.

In the chart all of these operations are already performed—the radii are squared, exact outside pipe diameters are employed, and the proper factors are used.

*Contributed by W. F. Schaphorst, M.E., Newark, N. J.



The Editor's Comments

Canada Scores Again!

At meetings of American associations held in Canada more than one attendance record has been broken. The most recent case was that of the Minnesota Section of A.W.W.A. which held its annual meeting in Winnipeg, Sept. 1-3.

Because of the fact that a number of A.W.W.A. members residing in the Canadian provinces of Manitoba, Saskatchewan and Alberta are affiliated with the Minnesota Section for geographical reasons, and because W. D. ("Bill") Hurst, City Engineer of Winnipeg, was this year's chairman of the Minnesota Section, the 1948 meeting was held in Winnipeg.

With a current membership of 170 in the Section, the best estimates of anticipated attendance was "something less than 200" or "perhaps only 150" according to members who should have been most capable of predicting the probable attendance. Actually the paid registration was more than double the lower estimate—the record-breaking total being 330.

Hospitality proved to be the key-note of the Winnipeg meeting and held throughout, culminating with the all-day post meeting excursion and inspection trip via a "Waterworks Special" on the Canadian Pacific Ry. to the 80 mile distant Pointe du Bois, and Slave Falls hydro-generating stations of Winnipeg's prosperous publicly-owned Hydro Electric System. It was learned that the system, referred to as HYDRO, impressively retails electric current to taxpayers at the attractive figure of 0.774 cents K.W. average rate paid by the Winnipeg home-owner. At the city-owned village of Pointe du Bois, HYDRO employees served luncheon and supper to the 175 members and guests taking the trip as guests of Winnipeg.

Another unique and impressive feature of the Canadian meeting was the delightful dinner given by Winnipeg's long-time mayor—the Honorable Garnet Coulter, K.C.—and the Board of Aldermen. Equally impressive, and gratifying was the presence of the mayor and fourteen Aldermen with their ladies at the Section's annual dinner as guests of A.W.W.A.—noteworthy evidence of neighborliness, but more, perhaps, a show of local esteem for Winnipeg's appreciated "Bill" Hurst who as City Engineer has responsible charge of the Water & Sewage Works Systems of Winnipeg.

All in all the Winnipeg meeting stands, and will stand for sometime, as a high water mark in the history of the Minnesota Section—a mark to shoot at in planning future meetings.

Time was not available before press date for reporting of the impressive Canadian meeting in this issue, but we plan to report it in some detail in our next issue.

Sludge Merchandising at Marion

In this issue there is an account of the marketing and land disposal of liquid digested sludge at Marion, Indiana, which is deserving of more than passing interest.

For a matter of five years now, Supt. Backmeyer of the Marion plant has been disposing of liquid sludge from the digesters direct, or from storage lagoons, by tank-truck delivery to outlying farms. Not only is the liquid sludge delivered to the customer, it is actually spread over the fields which the farmer wishes fertilized. The nominal charge to the farmer for such humus bearing liquid manure is logically based on the distance hauled, as well as the gallonage spread on the land. The current scale of charging involves an attractive rate of 10 cents per mile for each 1,000 gallons delivered, with deliveries limited to a 5 mile haul from the plant. The latter limitation on haulage is practiced in order that accumulated sludge may be removed from the plant at a more rapid rate during delivery seasons by the two tank trucks available. Likewise, it is also a fact that the value of the liquid sludge is not sufficient to justify the transportation costs when delivered more than 5 miles (10 mile round trip) from the plant.

While Mr. Backmeyer points out that at the rates charged there is no *actual* profit from the sale of sludge at Marion, he states that the income from sludge sales reduces the overall cost of sludge disposal by a worthwhile amount, and thus makes the method more attractive from a net cost standpoint than other disposal schemes earlier practiced at Marion. In addition there is a certain satisfaction in practicing conservation through the return of such fertility values to the land.

Mr. Backmeyer does not include the following consideration in his evaluation of liquid sludge in comparison with de-watered sludge, but it is true that much of value in the form of highly soluble and immediately available ammonia salts resides in the digester supernatant, as "mother-liquor," which is ordinarily wasted to the stream when digested sludges are de-watered.

In particular for the smaller plants does the Marion method of sludge disposal hold an appeal, even though the method may require an increased digester capacity to serve the dual purpose of improved plant performance, and a reservoir for sludge storage during periods when conditions for field spreading from a tank-truck are not favorable, or may be inconvenient for one or another reason.

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The sturdy construction of the Comminutor is the result of long experience. The drum is a single casting, precision machined to close tolerances. Cutting bars, combs and teeth are firmly seated, yet easily removable for sharpening or replacement. They are staggered and distributed to effect multiple small shearing actions. This, plus inertia of the drum in motion, and gearing, allows use of small motors with consequent power economy. No housing is required for the Comminutor.

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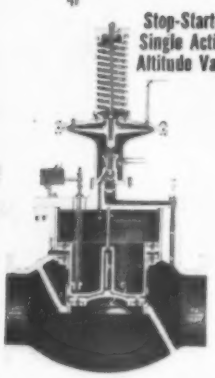

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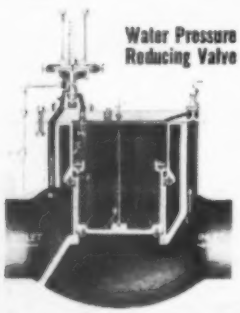

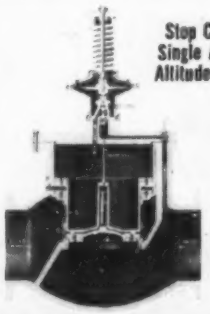

MEETINGS SCHEDULED

OCT. 5-6—FORT DODGE, IOWA (Hotel Wahkonsa)
Iowa Section A.W.W.A. Sec'y, H. V. Pedersen, Municipal Bldg., Marshalltown, Iowa.

OCT 7-8—MANSFIELD, OHIO (Mansfield-Leland Hotel)
Ohio Section A.W.W.A. Sec'y, F. P. Fischer, 812 Perry Payne Bldg., Cleveland 3, Ohio.

OCT. 10-13—GALVESTON, TEXAS (Buccaneer Hotel)
Southwest Section A.W.W.A. Sec'y-Treas., L. A. Jackson, Robinson Memorial Auditorium, Little Rock, Ark.

OCT. 13—FRYEBURG, ME.
Maine Water Utilities Association. Sec'y, Earle A. Tarr, Supt. Water District, Winthrop, Me.

OCT. 13-15—ATLANTIC CITY, N.J. (Haddon Hall)
Pennsylvania Water Works Association (52nd Annual Meeting). Sec'y, E. R. Hannum, P. O. Box 315, Windber, Pa.

OCT. 13-15—BOSTON, MASS. (Statler Hotel)
American Society of Civil Engineers. (Fall Meeting.) Asst. Sec'y, Allen Wagner, 33 West 39th Street, New York 18, N. Y.

OCT. 13-15—MONTGOMERY, ALA. (Whitley Hotel)
Alabama-Mississippi Section A.W.W.A. Sec'y, John L. Snow, First National Bank Bldg., Montgomery, Ala.

OCT. 15-17—PHOENIX, ARIZ. (Hotel Westward Ho)
Arizona Water & Sewage Works Association and Arizona Section A.W.W.A. Sec'y, Helen Rotthaus, Sanitary Engineering Div., State Capitol, Phoenix, Ariz.

OCT. 17-20—BOSTON, MASS. (Copley Plaza Hotel)
Public Works Congress. Executive Director, Donald F. Herrick, American Public Works Association, 1313 East 60th St., Chicago 37, Ill.

OCT. 18-20—PITTSBURGH, PA. (Hotel Wm. Penn)
Engineers' Society of Western Pennsylvania. (Ninth Annual Water Conference) Chairman, H. M. Olson, 171 Longue Vue Drive, Mt. Lebanon, Pa.

OCT. 18-21—DETROIT, MICH. (Hotel Statler)
Federation of Sewage Works Associations. Sec'y, W. H. Wisely, 325 Illinois Bldg., Champaign, Ill.
Michigan Sewage Works Association. Sec'y-Treas., R. J. Smith, 545 Elizabeth St., E. Lansing, Mich.

OCT. 20-22—PHILADELPHIA, PA. (Hotel Penn Sheraton)
4-States Section A.W.W.A. Sec'y, W. A. Welch, 748 Public Ledger Bldg., Philadelphia 6, Pa.
(Joint Meeting)
Western Penna. Section A.W.W.A. Sec'y, L. S. Morgan, State Department of Health, Greensburg, Pa.

MEETINGS SCHEDULED

OCT. 24-26—JEFFERSON CITY, MO. (Hotel Governor)
Missouri Section A.W.W.A. Sec'y, W. A. Kramer, State Office Bldg., Jefferson City, Mo.

OCT. 25-26—RICHMOND, VA. (Hotel John Marshall)
Virginia Section A.W.W.A. Sec'y, W. H. Shewbridge, 708 State Office Bldg., Richmond 19, Va.

OCT. 25-29—STATE COLLEGE, PENNA. (Nittany Lion Inn)
Pennsylvania State College Water Works Operators' School. Director, R. E. Stiemke, Dept. of Civil Engineering, State College, Pa.

OCT. 26-27—SPRINGFIELD, ILL. (Leland Hotel)
Illinois Water Works Operators' Association. Sec'y, C. E. Corrington, Clinton, Ill.

OCT. 27-29—RIVERSIDE, CALIF. (Mission Inn)
California Section A.W.W.A. Sec'y, H. C. Medbery, Water Department, 425 Mason St., San Francisco, Calif.

OCT. 28-29—LA CROSSE, WIS. (Hotel Stoddard)
Wisconsin Section, A.W.W.A. Sec'y, L. A. Smith, City Hall, Madison, Wis.

NOV. 1-3—OTTAWA, CAN. (Chateau Laurier)
Canadian Institute on Sewage & Sanitation. Sec'y, A. E. Berry, Ontario Dept. of Health, Parliament Bldgs., Toronto, Ont.

NOV. 4-6—ATLANTIC CITY, N.J. (Madison Hotel)
New Jersey Section, A.W.W.A. Sec'y, C. B. Tygert, Box 178, Newark 1, N. J.

NOV. 8-10—ASHEVILLE, N.C. (Hotel George Vanderbilt)
North Carolina Section A.W.W.A. Sec'y, G. S. Moore, Supt. Water & Light, Albemarle, N. C.
and
North Carolina Sewage Works Association. Sec'y-Treas., G. S. Moore, P. O. Box 125, Albemarle, N. C.

NOV. 8-12—BOSTON, MASS. (Sessions-Mechanic Bldg.)
American Public Health Association. Sec'y, Dr. Reginald M. Atwater, 1790 Broadway, New York 9, N. Y.

NOV. 18-20—PANAMA CITY, FLA. (Hotel Dixie Sherman)
Florida Section A.W.W.A. Sec'y, S. K. Keller, Box 151, Clearwater, Fla.

DEC. 6-8—AUGUSTA, GA. (Sheraton Bon Air Hotel)
Southeastern Section A.W.W.A. Sec'y, W. T. Linton, State Board of Health, Wade Hampton Office Bldg., Columbia, S. C.

DEC. 8—WATERVILLE, ME.
Maine Water Utilities Association. Sec'y, Earle A. Tarr, Supt., Water District, Winthrop, Me.

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Steel shortages and rising prices keep major replacement costs HIGH

while maintenance costs remain low

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Rotary Positive Blower of 12,500 CFM capacity, with direct-connected motor drive.

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1. Long experience in the adaptation of blowers to needs of sewage plants and waterworks, coupled with the forward-thinking of our alert engineers.
2. Our *dual-ability* to supply either Rotary Positive or Centrifugal Blowers, whichever type is best fitted to the specific work.
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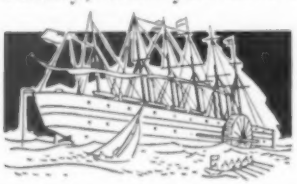
Finally, when you have selected the R-C Blower that satisfies your requirements, you can be certain of sound, sturdy construction, low maintenance and operating costs, and a long life of profitable performance. For accurate answers to your blower questions, consult us.



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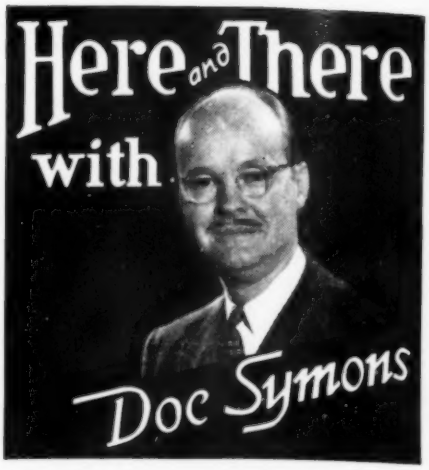

H.T.M.A.—And believe it or not—I'm actually on vacation, or, as my Canadian friends would say, I'm having my holidays. Of course, at the moment, I'm taking time off to bat out this column for the October issue, but it's pleasant here in our back yard, and I can look around and see the results of three days at home—a huge clump of rhododendron shrubs cut back to window height, and the privet hedge neatly trimmed down to eight feet high (all 120 feet of it). And I can muse about the whole afternoon I spent trying to straighten out my files; and I can remember that only yesterday I put two edited articles in the mail, and—But as soon as I finish this I'm off for a change of scenery. Right now it seems odd that it will be almost eight weeks after I write this, before you see it. I wonder how words written on a warm August afternoon will read about World Series time.

* * *

When this column appears, it will be just about three weeks before the Federation meeting in Detroit, and just about five weeks before the 1948 presidential election.

I should like to remind Al Genter (Balto. Cons. Engr.); Gordon Fair (Dean, Harvard Grad. School); and "Bill" Piatt (Durham, N.C. Cons. Engr.) that we four have a four year old date to resume our debate on presidential candidates.

You may remember that our first meeting was in 1940 at the Hotel Sherman in Chicago where we discussed the matter of a third term. As I recall it, "Bill" Piatt was voting for the Democratic candidate that year. We next met in the Hotel William Penn in Pittsburgh in 1944, and discussed fourth term candidates, etc., and as I recall it Mr. Piatt was again voting for the Democratic candidate.

Well boys, it's another year, another convention, another city, another

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- UNIFORMITY OF STRUCTURE
- RUGGEDNESS
- LOW PRESSURE LOSS
- CORROSION RESISTANCE
- DURABILITY

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Used in various phases of primary and secondary sewage treatments, these tubes and plates assure continuous uniform air supply. Diffused in smaller bubbles, oxygen absorption is higher. More efficient treatment results.

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Available to advise on specifications, installation and operation of ALOXITE diffusers is an engineering staff familiar with the sewage field. Their background of technical and practical experience may be of invaluable assistance to you. Feel free to consult them. Write Dept. M-108, The Carborundum Company, Refractories Division, Perth Amboy, N. J.

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hotel, and another candidate, or two. Wonder for whom that transplanted dam-yankee Piatt is going to vote this year.

Incidentally gentlemen, in case you've forgotten, each previous meeting was held while enjoying the hospitality of the boys from W & T. Shall we call on them again for our quadrennial discussion?

* * *

Well, what d'y'know—Arnold R. Smith, one of Yale's recent graduates (Engineering School) is now working for Malcolm Pirnie Associates.—Wonder if he can dance like "Dick" Hazen?

* * *

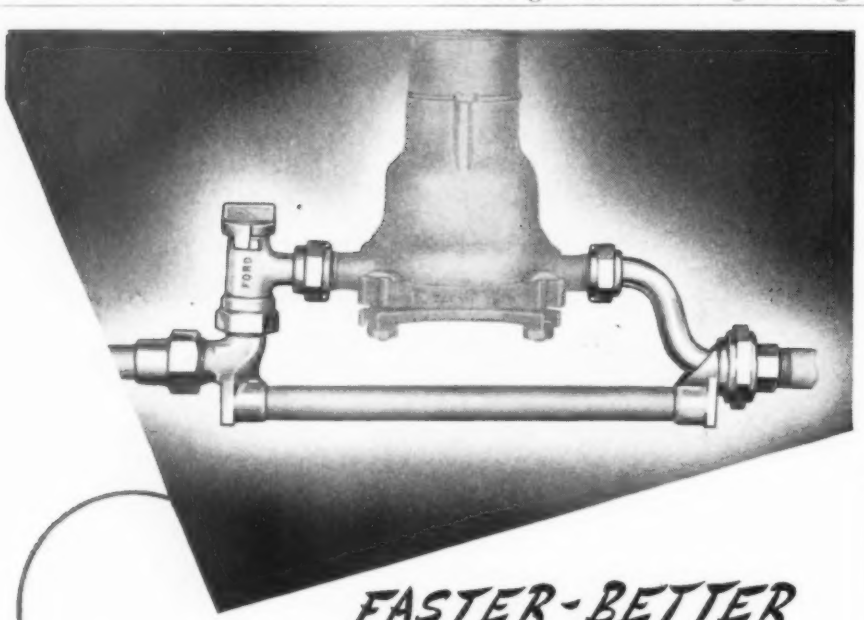
Did you know that George Russell, Cons. Engr. of St. Louis, Mo., and currently President of the Federation of Sew. Wks. Assns., was once a semi-pro ball player? In fact a player-manager of one of those mid-west teams a few years back.

"Better manager than player," recalled George as we lunched in Milwaukee last June, "but once—Ah, that was a game to remember.—I came to bat first in one of the late innings and we were trailing 2-0. I smacked the first pitch and came into third standing up. Right then I yelled to my boys, 'If I can do it, everyone can'.—And you know the next eight batters got hits. I even got a single my second time up, and before that inning was over 14 of our men had faced that pitcher.—It was a game to remember." Once in a lifetime, eh, George?

* * *

If you thought I was finished with the Atlantic City A.W.W.A. Convention, you should know me better.—This might be titled "Even the big boys forget sometimes."

I show you here the bonafide signature of the immediate past president of A.W.W.A., one "Tom" Veatch, who forgot his tickets for the annual banquet at Atlantic City.



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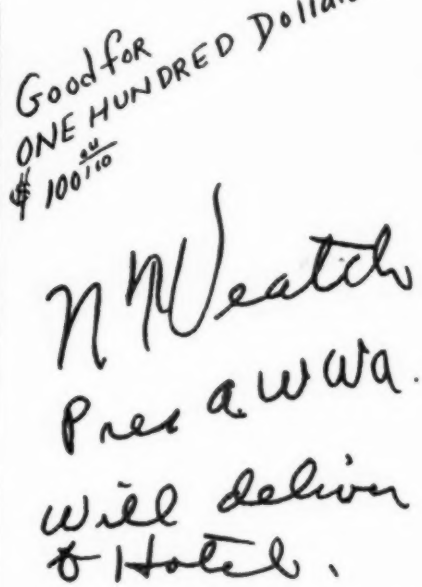

Tom wrote the above promissory note for the waiter. It was countersigned for the $100 value by "Bill" Orchard, who conveniently neglected to sign his name.

Apparently the scheme worked, for I distinctly saw Tom Veatch eating dinner—Turkey, That Is.

* * *

Have you ever wondered how many persons read this column?—I have—and so I undertook to find out. I conducted one of those scientifically distributed polls via a questionnaire. It drew an acceptable response and I am glad to report to you the following bit of statistical appraisal:

—Out of every 100 subscribers (we have about 7000), 48 read this column regularly, 29 skim it for items of interest, 24 read it occasionally, and 9 don't read it at all.—Is that good?

Among the consulting engineers, I don't rate so well—They're interested in the serious stuff, no doubt. Libraries are fifty-fifty readers, apparently, but Miss Alice C. Dean, Librarian of Rice Institute at Houston, wrote that she had no record of

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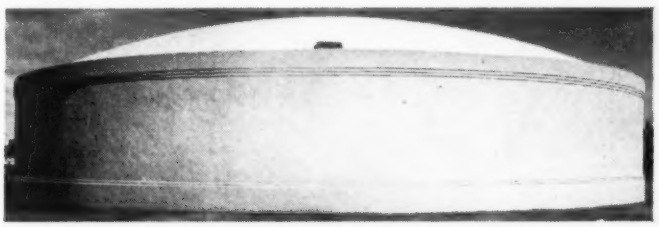

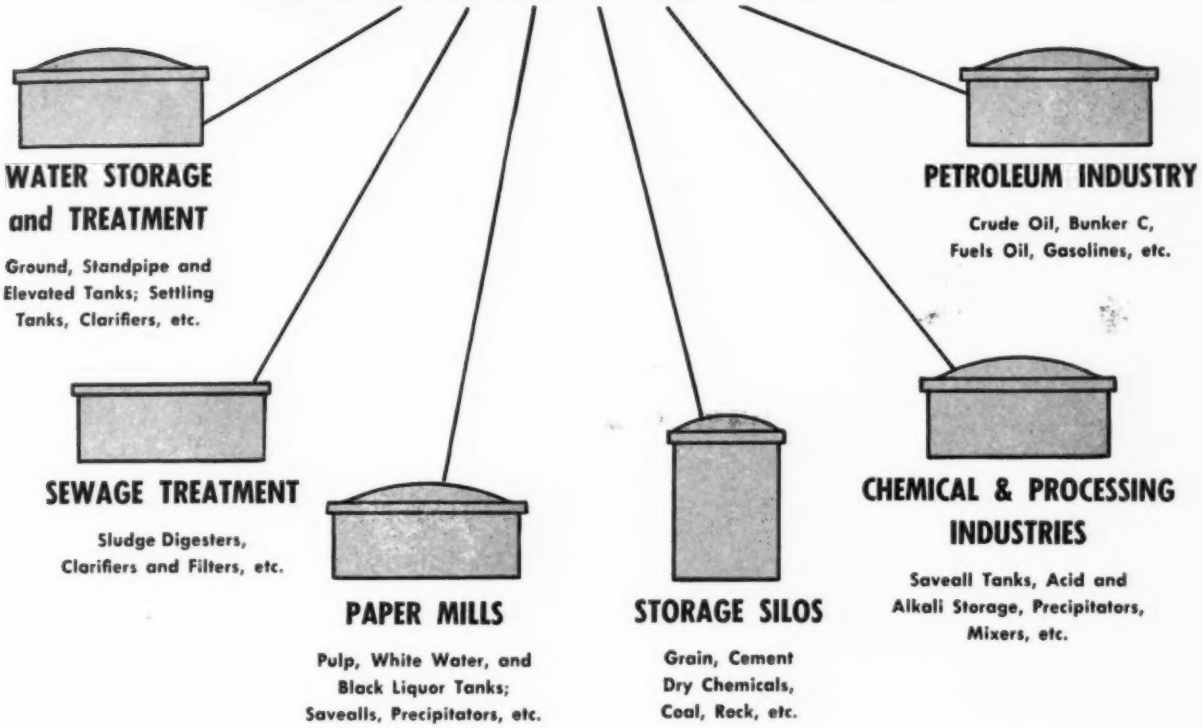
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use available, which means that she, too, doesn't read my stuff.

A mere fifth of those subscribers replying know me personally, but of that group, 85 per cent are avid readers of Here and There. (Does that mean I should get around more?) One admirer wrote, "you are good", and another said he "read the column enthusiastically"—To offset this heady praise, one "literary critic" from California wrote that "Symons' articles are terrible."

One thing I'd like to know—How to get those occasional readers into that regular category.—And I must report that the poll was lacking in one respect, in that it did not query any of my feminine readers, mostly wives of subscribers—and I know I have a goodly number of these.—Remember, Mr. Advertiser, "Never underestimate the power of a woman."

* * *

Flash! "Jim" Walker—the BIG man who sells J-M's "Transite" pipe in New York state, has stopped smoking and has switched to water.—Better watch your diet now, Jim, or that 295 pounds of yours will be as big as "Huge" Dewey of Buffalo.

* * *

Although I've enough material to write a whole column on the June meeting of the Cent. States Sew. Wks. Assn., right now, I've just space to tell you that it was there that I discovered that Olive (Mrs. Paul) Troemper, of the Ill. Dept. of Health Troempers, is a fellow Univ. of Ill. alumnus, a journalism school graduate, a fellow would-be writer, and an artist. In fact you might say that it was at that Milwaukee meeting that I discovered Olive Troemper. Anyway, witness here her artistic ability as evidenced by this sketch made in a *Water & Sewage Works* Notebook of "Billie" Allen, wife of "Bill" Allen, wife of Allen, the Northwestern Representative of the Chicago Pump Co. in Milwaukee.

Yes, I had the pleasure of dining that night with the Allens, Harry and Norma (P.F.T.) Schlenz, and the Troempers.—I always meet such interesting people, wherever I go.

* * *

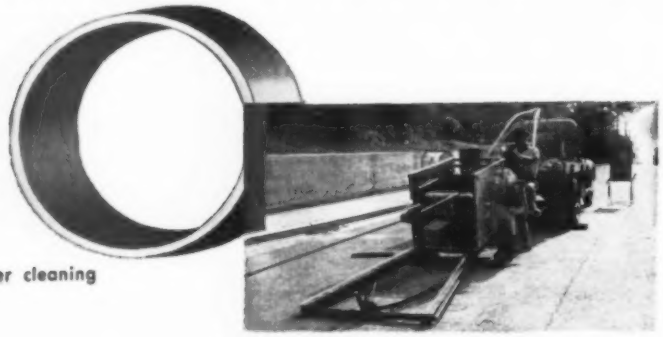
On Aug. 9, I was reading John Crosby's column, "Radio in Review" in the *N.Y. Herald Tribune*, and was delighted to see that Mr. Crosby (John, that is) had been reading (No—Not *W. & S. W.*) *The Water Works Officers Journal* of England.

Mr. Crosby, it seemed, was interested to learn from an article by M. H. Finch of England that water pressures soar at times of important radio programs, when the listening public is large. For example, Mr. Finch pointed out that during the Armistice Day ceremonies in 1938,

Before cleaning

A CLEANING JOB THAT LASTED 30 YEARS

After cleaning



Special Power Winch for pulling cleaning head through pipe.

Just 30 years ago the water mains of the city of Toledo, Ohio were successfully cleaned by National.

The thoroughness with which National performed that initial job, along with the exceptionally fine water treatment system installed by Toledo's Water Works Department has enabled the original cleaning to last *30 years.*

It was because of that unusual record that Toledo's progressive water works department *has again selected National* to clean its entire water main system—a program that will take over five years to complete.

Tests made on those lines already cleaned by National indicate higher pressure and increased carrying capacities, resulting in greater fire protection for Toledo's outlying districts.

There's no obligation to have a National engineer estimate the cost of cleaning your lines. Why not write *today!*

30

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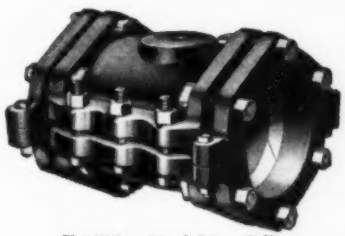
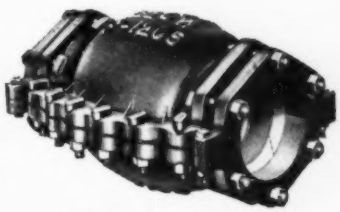
ATLANTA, 1221 Mortgage Guarantee Building • BOSTON, 115 Peterboro Street • CHICAGO, Room 1336, 122 So. Michigan Avenue • HOUSTON, 2518 Grant Street • KANSAS CITY, 421 BMA Building LOS ANGELES, 448 South Hill Street • MEMPHIS, 822 Dermon Building • OMAHA, 3812 Castellar Street • RICHMOND, 210 East Franklin Street • SPRINGFIELD, MO., 844 North Main Street • SALT LAKE CITY, 149-151 W. Second So. Street • SAN FRANCISCO, 681 Market Street • MONTREAL, 2028 Union Ave. • VANCOUVER, B. C., 505 West 1st Ave. • WACO, P. O. Box 887 • WINNIPEG, 576 Wall Street • HAVANA • MAYAGUEZ, PUERTO RICO • BOGOTA • CARACAS • MEXICO CITY

DID I TELL YOU ABOUT...



F-1200 Straight Split Sleeve. For repair of break up to 8 inches in barrel of pipe.

Clow Mechanical Joint Split Sleeves for Repairing Mains & Reinforcing Joints

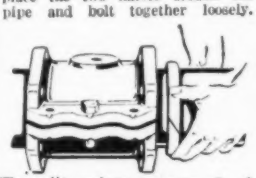


F-1205—Bell Split Sleeve For repairing break through joint, or for reinforcing Joints wherever advisable.

1

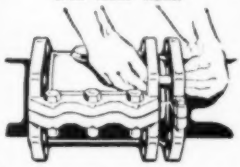
With the side rubber gaskets in the grooves in the face of the side flanges of the bottom half of sleeve, place the two halves around the pipe and bolt together loosely.

2



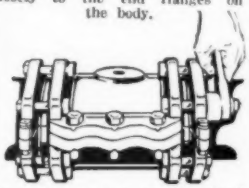
The split gaskets are next placed around the pipe at each end, and pushed to their seat inside the sleeve body. All body bolts are then made tight.

3



The split glands are next bolted together around the pipe—one at each end of sleeve—and then bolted loosely to the end flanges on the body.

4



By ratchet or box wrench, gland bolts are tightened a little at a time—moving from one to another in order to apply gland pressure evenly on the end gaskets.

Because of its great simplicity, Maintenance Men welcome the F-1200 CLOW SPLIT SLEEVE for quick and positive repair of breaks in pipe barrel, and the F-1205 BELL SPLIT SLEEVE for breaks too long for the F-1200, or for repair of reinforcing Joints. With only one tool—a ratchet or box wrench—an average workman can apply these Sleeves and make a permanent repair. This is invaluable in an emergency. No jute, no lead, and no calking necessary. A definite time-saving device for maintenance crews. And always—THEY STAY PUT.

Following soon after the first few sales of the Clow F-1205 Bell Split Sleeves, came word from the field of its manifold utility. Designed especially as an emergency repair Fitting for repairing a break in the Joint of underground Water Piping, Water Works men found it equally effective for repairing a break in the barrel of the pipe in the absence of a F-1200. Another important use for the Bell Split Sleeve is its application as reinforcement for cast iron pipe joints where underground piping is laid under Railroad tracks, Highway Truck Routes, or Submerged pipe lines across rivers, streams and other similar places where piping is difficult of access. This Bell Split Sleeve is always a valuable precaution around joints—consider its added protection.

CLOW SPLIT SLEEVES can be installed in a wet trench and even under water. This is a big advantage because it does away with the dangers of molten lead splash when it hits water. The heavy rubber gaskets used are confined to the joint space. This gives a tight, leak-proof, long-enduring job.

DESCRIPTION:—CLOW SPLIT SLEEVES consist of a body section, in two halves, with bolts through the flanges on each side; two moulded rubber gaskets for side flanges; two moulded rubber end gaskets split crosswise for placing around pipe; two split glands with joining bolts; and the necessary number of tee head bolts for connecting the glands to the end flanges on the body section.

Made in sizes 3-inch to 16-inch inclusive for use on A.W.W.A. Sand Cast pipe and Federal Spec. WW - P - 421 centrifugally cast pipe.

BE PREPARED. Order a reasonable reserve of Clow Split Sleeve F-1200 and F-1205 in sizes to match the piping sizes in your water distributing system. Sleeves are shipped complete and ready for instant use. Complete instructions for installation accompany each Sleeve.

You are invited to fully acquaint yourself with these Clow Mechanical Joint Split Sleeves and other current Clow developments. Write today for completely descriptive literature. No obligation.

JAMES B. CLOW & SONS

Manufacturers of Cast Iron Pipe and Fittings for Underground Pipe Lines;
Eddy and Iowa Valves and Fire Hydrants;
Specials for Water Treatment and Sewage Disposal Plants;
Manhole Frames and Covers; Street and Roadway Castings.

201-299 North Talman Avenue **Address Mail to P. O. Box 6600-A** **Chicago 80, Illinois**

the water pressure in one city rose from 80 to 108 psi., while the two minutes of silence were being observed; and when the King's 1937 Christmas Day Message was being broadcast, the pressure went from 110 to 130 psi.

Mr. Crosby suggests (with tongue in cheek, apparently) that instead of Crosley polls, and Hooper Ratings, radio executives might well use the local water pressure as a measure of a program's popularity.

Mr. J. C. doesn't know how well he speaks.—Take the case of the eastern city where, immediately after the end of the first Louis-Walcott fight, the water pressure dropped ten pounds for several minutes. (Water pressure, Mr. C., drops when there is a sudden excessive usage—and vice versa). It appears, in one city at least, that the conclusion of that particular radio program released a general trek to that masterpiece of modern plumbing which requires approximately 3½ gallons of water for each filling.

* * *

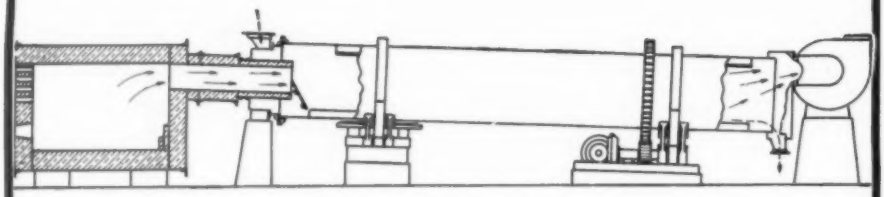
Birthday congratulations on the 25th to Clarence Klassen, Chief Engr., Ill. Dept. of Health.

Now that George Martin, Supt. of Green Bay San. Dist., has been elected to represent the C.S.S.W.A. on the Federation Bd. of Control, and "Very Truly Yours" to represent the N.Y.S.S.W.A. and Don Bloodgood (Purdue Prof.) as Director at Large, some one is sure to remember that we three were undergraduate classmates together at Wisconsin.—First time we all vote alike on some question, no doubt, we'll be tagged the Wisconsin Block.

Incidentally, George and Isobel (Martin) sent us that famous aged Wisconsin cheese and our gin rummy playing guests love it.—We'll be ready for some more in a short while.

Well now, folks, I'm really off for my holidays—V.T.Y.—Doc.

SLUDGE DRYER

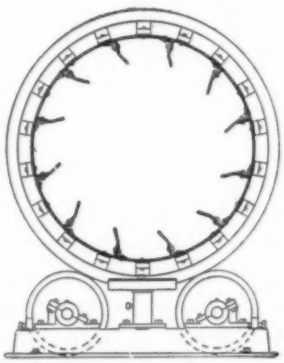


Cross section of "XH" dryer showing feed and discharge as well as hot-gas flow.

The Ruggles-Coles Class "XH" Rotary Dryer, made by Hardinge, has high thermal efficiency, very small radiation loss, and low exhaust temperatures. It is ideal for the rapid dehydration of garbage, sewage sludge, and other materials of high moisture content. It is particularly adapted for drying relatively sticky materials.

Hot gases travel through the shell in the same direction as the material flow, while lifting flights —designed to suit the material— create a showering effect which causes very rapid drying. For additional information write for Bulletin 16-C.

See our exhibit at the Sewage Works Convention, Hotel Statler, Detroit, Michigan, October 18-21.



Section at right angles to axis of "XH" dryer showing lifting flights.

HARDINGE
COMPANY INCORPORATED
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NEW YORK 17—122 E. 42nd St. • 205 W. Wacker Drive—CHICAGO 6
SAN FRANCISCO 11—24 California St. • 200 Bay St.—TORONTO 1

THE SPILLWAY

[Overflow from the main section]

U.S.P.H.S. Sanitation Survey Report Available

In the August 1947 issue of *Water & Sewage Works* the U.S.P.H.S. survey of sanitation needs for the United States was reported. That issue summarized the information on a complete survey of the country. The entire report is now available in printed form from the Public Health Service.

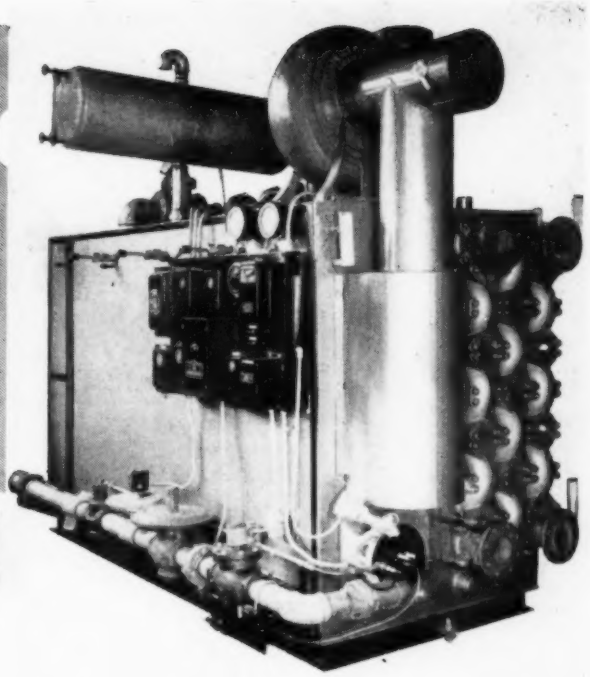
The survey which was made by the Sanitary Engineering Division of the Federal Security Agencies Public Health Service, shows the cost of needed water supply and waste disposal facilities to be estimated at $7,834,581,000. This is the first attempt that was made to survey national needs for sanitation facilities.

According to the report more than 2 million persons, living in communities of 200 or more population, have no community water supply systems and 79 million persons have systems needing improvements. Less than 11 million persons live in communities for which no water supply improvements are needed or scheduled. More than six million persons in towns and cities need new sewerage systems and 79 million need improvements in sewerage systems.

In rural areas, more than 27 million people need new or improved water

KEY

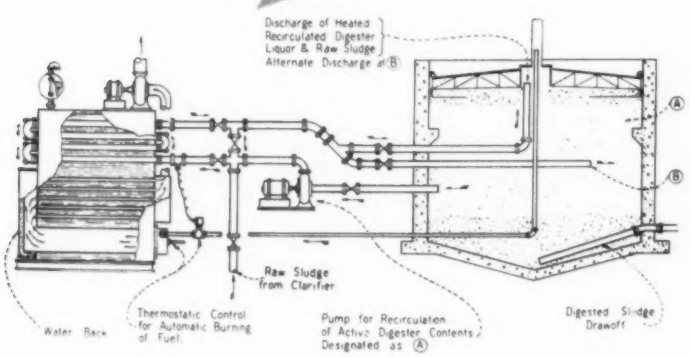
To Trouble Free Digestion Tank Heating



No. 1000 Heater and Heat Exchanger for Stockton, California. Engineering Office of Clyde C. Kennedy, San Francisco, Consulting Engineers.

P.F.T. Digester Heater & Heat Exchanger

The P. F. T. Digester Heater and Heat Exchanger is a compact unit of high thermal efficiency for heating and recirculating digester material *OUTSIDE THE DIGESTION TANK*. It makes possible accelerated digestion through the pre-heating of raw sludge being added and eliminates these troubles common to heating coils immersed in the digesting mass: (1) Need for holding temperature below 135° to avoid scorching of sludge, (2) Build-up of insulating coating on coils which interferes with maintaining proper digestion temperature, (3) Inaccessibility of coils for repair and cleaning necessitating putting tank and often entire system out of operation.


Discharge of Heated Recirculated Digester Liquor & Raw Sludge Alternate Discharge at (B)
Raw Sludge from Clarifier
Thermostatic Control for Automatic Burning of Fuel
Pump for Recirculation of Active Digester Contents Designated as (A)
Digested Sludge Drawoff
Water Back

The P. F. T. combined heater and heat exchanger consists simply of a tank filled with water and heated by immersion type fire tubes. Through this same water passes the tubes which carry the recirculated material from the digester. The No. 1000 unit shown is arranged for automatic gas and oil firing, automatic digester temperature maintenance, building heating, engine cooling, and has complete flame safety protection. Normal Output: 1,000,000 B. t. u. per hour for digester heating plus 500,000 B. t. u. per hour for building heating.

Visit Booths 41 and 42 At Your Detroit FSWA Convention

P.F.T *Pacific Flush-Tank Co.*

4241 RAVENSWOOD AVENUE, CHICAGO
NEW YORK CHARLOTTE, N.C.

SEWAGE TREATMENT EQUIPMENT EXCLUSIVELY SINCE 1893

LOS ANGELES — SAN FRANCISCO — DENVER — TORONTO

supplies and more than 33 million have unsatisfactory sewage disposal systems.

To remedy the situation, Assistant Surgeon General Mark D. Hollis, Chief of the Sanitary Engineering Division, pointed out that the nation needs an additional 2.2 billion dollars worth of water works; and 3.7 billion dollars worth for sewage facilities; plus 166 million dollars for garbage facilities; and 1.6 billion dollars of all types of sanitation facilities for rural homes. The cost estimates are based on June 1946 construction costs.

Printed copies of the survey report are available from the Superintendent of Documents, Supplement No. 204 (Nation-wide Inventory of Sanitation Needs) to the Public Health Reports, April 1948, at 15 cents.

Reprints of the article in *Water & Sewage Works* the August, 1947, issue of which summarized the report are available from this magazine.

Water Treatment For Rural Homes

Bulletin No. 89 of the Agricultural and Mechanical College of Texas is titled *"A Surface Water Treatment System For The Rural Home,"* and was written by Joe B. Winston, Associate Professor, Dept. of Preventive Medicine and Public Health, the University of Texas, Medical Branch. This bulletin contains information on the equipment, construction, installation details, operation, and maintenance of the treatment system.

Water Purification Control

"Water Purification Control" by Edward S. Hopkins, Associate Engineer, Bureau of Water Supply, Baltimore, Md., has been published in its third edition.

This third edition has been revised and brought up-to-date, so that this short guide in filtration plant control is of practical value to persons in charge of water purification plants. A number of the chapters have been rewritten and enlarged to add to their value.

The book contains 11 chapters plus a series of useful tables. The chapters include information on coagulation, color removal, removal of iron and manganese, sedimentation, filtration, disinfection, taste and odor control, corrective treatment, and softening.

"Water Purification Control" is published by the Williams & Wilkins Company of Baltimore, Maryland.

Sewerage Design and Specification

"Sewerage Design and Specification" is authored by L. B. Escritt, Chartered Civil Engineer, London, England.

The book consists of 9 chapters, 4 appendixes, a bibliography, a list of abbreviations, and an index of specification clauses. The chapters are devoted to such subjects as general principles of sewerage, soil sewerage, surface water sewerage, land drainage, construction of sewers, manholes and chambers, flushing and ventilation of sewers, conditions of surcharge, and sewerage of coastal towns.

The book is intended for the designer as well as the wider public, in that it explains the main principles of sewerage in a manner that should make the subject clear to the student who is not necessarily a civil engineer.

The book contains 329 pages plus 10 pages of advertising by various English firms engaged in construction of sewage treatment equipment. "Sewerage Design and Specification" is published by *The Contractors' Record* and *Municipal Engineering*, Lennox House, Norfolk Street, W.C. 2, London.

KALKTITE

COLD APPLIED SEWER JOINT SEALER

Kalktite being used to seal pipe joints on the Sewage Disposal Expansion Program, Greenville, Miss. The City of Greenville has specified Kalktite for years.

Sets Up Internally Even Under Water

. . . Resists Roots and Acids

Wet trenches do not delay the job when you use Kalktite, cold applied Sewer Joint Sealer. It sets up under water, will not wash away or remain soft. It sets to a hard, tough body that is flexible and permits settlement of pipe in the trench without breaking the joint.

Kalktite contains an ingredient that is poisonous to vegetation and tree roots. It is not affected by sewer acids and gases or alkali. Mixed right on the job, Kalktite is easy to use and handle.

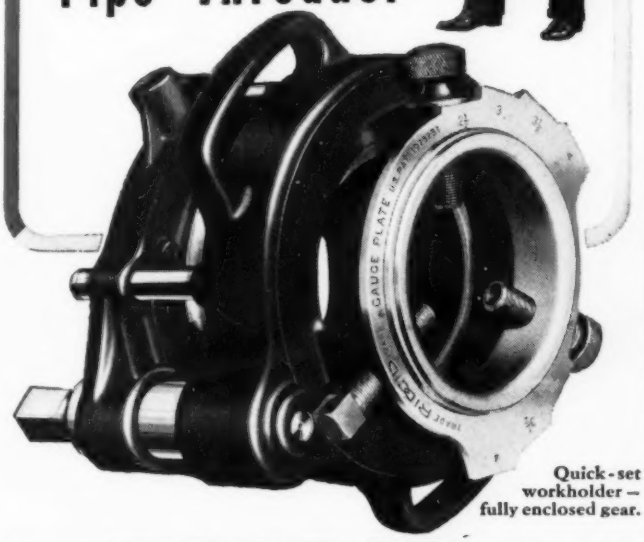
Write for sample and complete specifications.

PRESSTITE SEALING COMPOUNDS

PRESSTITE ENGINEERING COMPANY

PEC-177 3918 Chouteau Ave. • St. Louis, Mo.

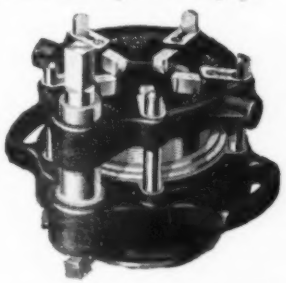
At Last! ...a much easier-to-handle 2½" to 4" geared Pipe Threader



Quick-set workholder — fully enclosed gear.

New RIDGID No. 4P

● Now you can have a 2½" to 4" geared threader you can handle with unusual ease — carry it, put it on pipe; it's got handles you can get hold of and control it with. That's only one of the many RIDGID features of this new 4P die stock that you'll enjoy.



Balanced Loop-handles. Easy to pick up and put straight on pipe — won't slip or tip over. Easy to carry. . . .

Quick-setting Workholder. Mistake-proof — sets to size *before* you put it on pipe, no bushings. . . .

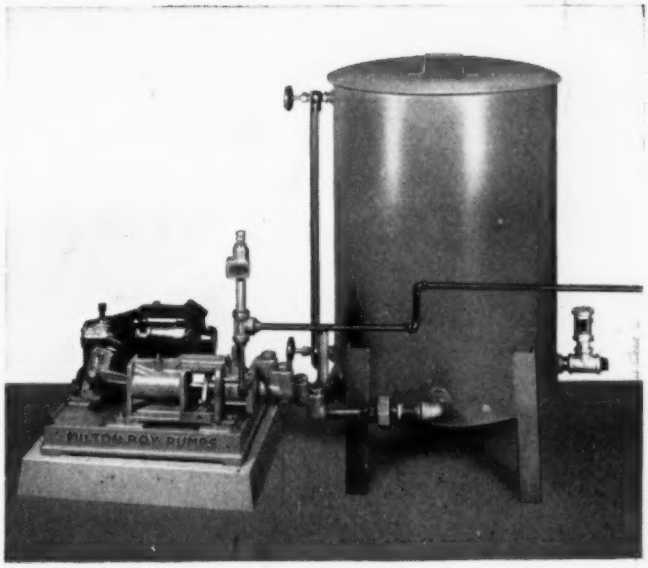
Extra Easy Upkeep. Twin-anchored drive shaft turns in oilless bronze bearing — never needs oil. Grease packed gear fully enclosed. . . .

Easy Pipe Threading. Four sets of 5 high-speed steel dies easily cut clean accurate threads. Ratchet handle with each 4P; RIDGID universal drive shaft available for power drive.

Make sure of these easier-work advantages — buy the 4P at your Supply House.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

MILTON Roy CHEMICAL PUMPS

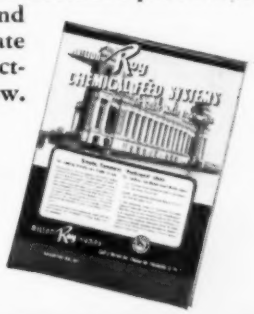


Complete Feed Systems for Boiler Water Chemical Treatment

Milton Roy "Packaged" Units for chemically treating boiler water are available to feed sodium sulfite into the suction side of the feed water pump and to feed other chemicals, such as phosphates, soda ash and caustic directly into each boiler. Both methods are usually recommended for the correct treatment of boiler water.

- TO REMOVE DISSOLVED OXYGEN, INSURE AGAINST CORROSION AND PREVENT PITTING.
- TO PREVENT SCALE FORMATIONS, CONTROL ALKALINITY AND PREVENT EMBRITTLEMENT.

Units are complete with Milton Roy Pumps, tanks, gages, low-level pump cutouts and alarms . . . are available in a wide range of capacities to meet all requirements. Complete electronic controls and meters can be supplied to operate pumps automatically at rates directly proportional to feed water flow.



Write for Bulletin 451 also Technical Paper 51 "What the Power Engineer Needs to Know About Chemical Feed Systems for Water Treatment."

MILTON Roy COMPANY
1329 E. MERMAID LANE, CHESTNUT HILL, PHILA. 18, PA.

Treatment of Pickle Liquor

A new method of treating pickle liquor from steel mills has been reported by the Wheatland Tube Co. of Wheatland, Pa.

The method has been developed from experiments over a long period and the method consists of treating the pickle liquor waste with zinc waste from the galvanizing department to produce ferric hydrate and sulfate and chloride of zinc.

The Wheatland Tube Co. and Wheatland Steel Products Co. have formed a new company called the Maneely Chemical Co. which is now constructing a half million dollar plant to treat the pickle liquors with this new method.

The treatment equipment consists of crushing and screening apparatus, rotary kiln, jacketed glass lined reactors equipped with agitators, classifiers, rotary drum filters, monel evaporators and cooling systems.

The process converts the ferric hydrate into a raw material for the manufacture of yellow and red iron pigments or abrasives used in paint and ink and for polishing glass manufacturers.

Ferric sulfate or ferric chloride for sewage treatment can also be made. Markets for zinc sulfate and zinc chloride are limited, but these materials are used in agricultural sprays, rayon manufacture, glue, electroplating, and fluxes.

A.S.E.E. Committee Formulates Program for Sanitary Engineering Education

A committee of the American Society of Engineering Education has made an attempt to set down a statement of the formal educational needs for sanitary engineers. The committee consisted of Earnest Boyce, University of Michigan, Denneth W. Cosens, University of Texas, Harold B. Gotaas, University of California, William T. Ingram, American Public Health Association, George W. Reid, Georgia School of Technology, and Gilbert H. Dunstan, University of Alabama, Chairman.

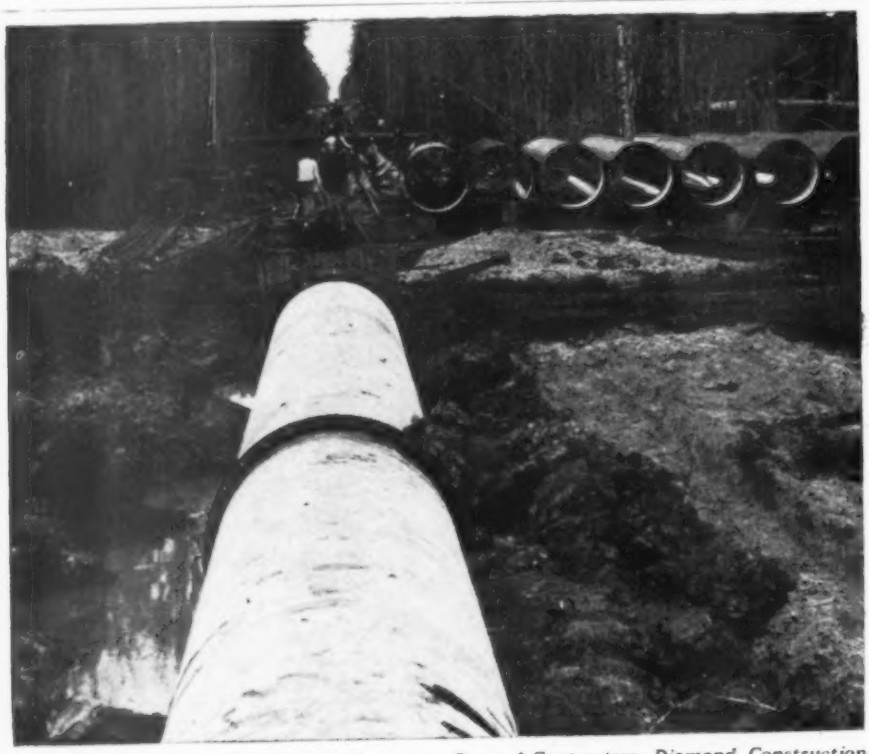
Accepting the detailed definition of the sanitary engineer outlined by the National Research Council in 1943, the committee set forth its ideas on the requirements of proper education for them to meet this definition, pointing out that every sanitary engineer should be adequately trained in the basic principles of engineering and should also have the so called "humanistic-social" studies included in the engineering curricula. The committee outlined the various detailed basic studies required as well as specialized instruction of bacteriology, sanitary chemistry, sanitary engineering laboratory, water supply, sewer drainage design, water purification, sewage treatment, public health and so forth.

The committee points out that a fifth year of graduate study is almost mandatory to a well educated sanitary engineer. The committee expects that within another year or so it may formulate a working program with more details on the matter particularly with reference to the master's degree in public health. A copy of the present report is available.

Metal Spraying Book

The American Metallizing Contractors Assoc. has been appointed sole United States distributor of W. E. Ballard's new book, "Metal Spraying and Sprayed Metal," 3rd edition by the London publishers.

The price of the book is $10.00 including postage anywhere in the U.S. Orders should be addressed to the Association at 773 Brownell Ave., St. Louis 22, Mo., and check included with order.



Consulting Engineers, J. E. Sirrine Company; General Contractors, Diamond Construction Company and Shepherd Construction Company; pipe supplied by Bethlehem Steel Company.

KOPPERS

BITUMASTIC*

PROTECTS THIS 14-MILE PIPELINE INTO SAVANNAH

THIS 14-MILE PIPELINE will carry 35,000,000 gallons of water daily to the City of Savannah, and to a large paper mill in the area. It passes through swampland where corrosion is the big problem.

To prevent corrosion from these severe conditions, the exterior of the pipe is protected with Koppers Bitumastic 70-B Enamel. For the pipe interior, freedom from corrosion, rust and tuberculation, and continued high flow coefficients are assured by a glass-smooth spun lining of the same impervious coating.

Specify Bitumastic coatings—proven leaders for over 90 years in protecting metal, concrete and masonry. Write for data on your particular problem.

KOPPERS

*Reg. Trade Mark, U. S. Pat. Off.

KOPPERS COMPANY, INC. DEPARTMENT 1018T PITTSBURGH 19, PENNSYLVANIA

Transite Sewer Pipe comes in long 13-foot lengths. These longer lengths require fewer joints in the completed line and make it easier to lay this pipe to line and grade. The result is a substantial saving in time and labor.

The light weight of Transite is another advantage that helps cut down installation costs . . . many sizes can be lowered into the trench without heavy mechanical equipment...and handling all along the line is faster and easier.

Transite offers lower excavation costs, too. Other important savings are possible with this pipe because it has an exceptionally smooth interior which offers minimum resistance to the flow of sewage. Its flow capacity is unusually high—n-.010. This often permits use of flatter grades and shallower trenches—with correspondingly lower excavation costs. Or, as an alternate economy, smaller diameter pipe may be used. Also, Transite Sewer Pipe is available in 4 strength classes, permitting selection of strength suitable to the job, and often eliminating need for concrete cradles.

Low maintenance through the years. Made of asbestos, cement and silica, Transite Sewer Pipe is steam-cured for unusual resistance to corrosion. Tight, sleeve-type joints safeguard against root trouble. And every length of Transite Sewer Pipe is factory-tested for strength and uniformity. This adds up to minimum maintenance costs through the years.

For Further Information, write Johns-Manville, Box 290, New York 16, N. Y.

*Reg. U. S. Pat. Off.

Life Jacket Dye Markers Found in Penna. Streams

In several instances this summer the Penna. State Dept. of Health has discovered that streams have become highly discolored from the contents of life jacket dye markers which were discarded along the waterway. Although the liquid from the markers is said to be harmless, the discoloration resulting from the material is causing considerable concern to people who use the streams.

These life jacket dye markers were part of the equipment of life jackets of fliers and life rafts during the war, the dye being used to discolor the water to permit the location of persons who came to distress in any body of water. It is quite probable that the markers containing the dye are still attached to rafts which are sold as war surplus material and that persons who purchased the rafts disposed of the dye by throwing it into the streams.

High Nitrate Waters Cause Blue Babies

Speaking before the Water, Sewage and Sanitation Chemistry Section of the American Chemical Society meeting in Chicago, James G. Weart, sanitary chemist of the Illinois Dept. of Public Health, reported that waters containing high nitrate concentrations were the cause of the disease known as cyanosis or the blue disease.

According to Mr. Weart, the disease which is particularly noticeable in infants, causing "blue babies", was first discovered in Iowa. The nitrate content of the water affects the baby's blood. The blood hemoglobin is altered so that it does not carry oxygen as it should. The blood itself becomes a chocolate color and the skin turns bluish or slate gray. Generally the disease is limited to babies under six months of age.

Mr. Weart reported that in Illinois 33 babies had the disease last year and five died.

Where to Dump Atom Plant Wastes

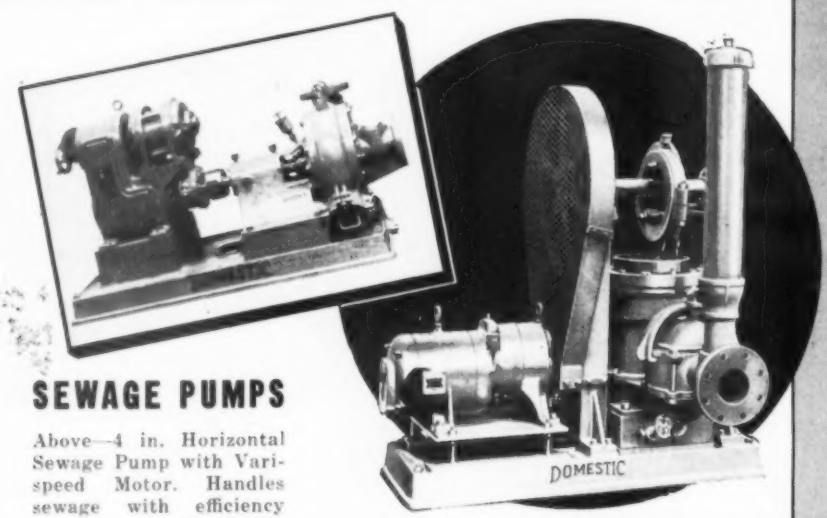
In the January issue of *Water & Sewage Works*, "Doc" Symons predicted in his column that "some smart program chairman in a Sewage Works Association will scoop the field by obtaining a speaker to discuss a new type of industrial waste, namely radio-active wastes from atomic ovens".

So far no sewage works association has scheduled such a discussion, but at the recent conference of the Greater New York Safety Council, Dr. Forest Western of the Oak Ridge National Laboratory, operated under the direction of the U. S. Atomic Energy Commission, raised that question.

Asking whether or not the radioactive plant wastes could be buried in the ocean, Dr. Western contributed this as a possible solution to the growing hazard. Dr. Western suggested that best method of disposal lay in using the concentrated waste solutions in the liquid for making concrete blocks which should be sunk in the deepest parts of the ocean. It is highly impractical to neutralize the toxic and potent radioactive waste material or to attempt to dilute it in lakes and rivers.

Dr. Western points out that even his solution is not completely satisfactory. The material must be isolated for a long time to partly decay into a stable isotope until the danger is removed. The extreme toxicity of the material is quite long-lived and this makes the waste a long range hazard. One isotope of the waste has a half-life of 24,000 years.

PUMPS that can "take it" and "dish it out"



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Above—4 in. Horizontal Sewage Pump with Varispeed Motor. Handles sewage with efficiency and economy. Also available, Vertical unit for varying conditions of service.

Above—EPS Simplex Type—Accessible and dependable. Also available Fixed and adjustable stroke—Simplex, Duplex and Triplex Units.

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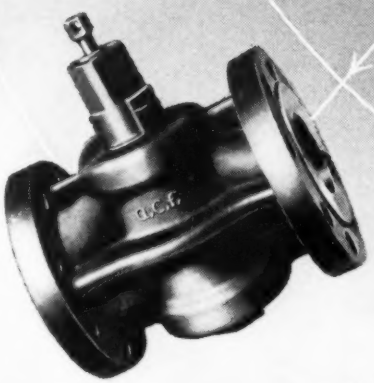

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N. Y. State Has Proposed Stream Pollution Control Act

At the spring meeting of the New York State Sewage Works Association held in Niagara Falls early in June, Earl Devendorf, Assistant Director, Bureau of Environmental Sanitation, N.Y. State Dept. of Health in Albany, spoke on the results of a two-year study of stream pollution control by the State Legislative Committee and presented comments on the act which has been introduced into the State Assembly for the purpose of controlling stream pollution in the State of New York.

Mr. Devendorf reviewed the studies of the State Legislative Committee which had pointed out that (1) serious pollution problems exist in every major watershed of the state; (2) although New York leads the nation in the number of persons served by sewage treatment works and ranks second in numbers of communities served by sewage works, the State is so highly urbanized and has so many industrial wastes that present works are inadequate; (3) industrial officials have shown a gratifying recognition of the harmful effects of the wastes discharged into surface waters; (4) that there is a growing dissatisfaction on the part of the public against the increasing amount of pollution of surface waters; (5) there are limitations and inconsistencies in the existing State Health and Conservation statutes relating to pollution control; and (6) many sources of pollution are local in nature and their correction must remain a local responsibility.

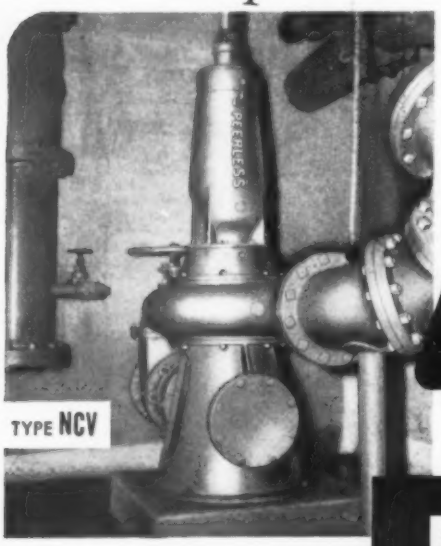
As a result of this two-year study, the Committee chairmanned by Assemblyman Harold C. Ostertag has prepared and introduced into the Assembly an act creating a Water Pollution Control Board, an act which will integrate and coordinate the work of the two state departments, Health and Conservation, which now have divided responsibilities over the control of pollution. Copies of the act are being sent to all counties, cities, towns, and villages, as well as to the industries. It is expected that the act, with any necessary amendments, will be presented for passage at the 1949 session of the Legislature.

The proposed bill contains the following provisions: (1) integration and coordination of work of the two departments, Health and Conservation; (2) correction of fundamental defects in existing laws and elimination of certain conflicts in present laws; (3) creation of a water pollution control board in the Department of Health; (4) utilization of existing personnel in the Health and Conservation Departments to administer the program and enforce the law; (5) authorization of the Board to classify waters of the state and to establish standards of water purity and quality; (6) public hearings on notices for all actions; (7) four prohibitions under the law.

These include the prohibition of discharges of polluting substances into waters in contravention of the Board's Classification of Waters and Standards of Purity adopted. Also prohibited are new outlets for the discharge of sewage and industrial wastes. It prohibits the discharges into the marine district of substances harmful to shellfish, and prohibits the construction of new or changes and extensions of existing sewer systems or treatment works without prior approval of the Board.

The proposed bill is designed to prevent undue hardship in the enforcement of the above prohibitions

The Pump with the Impeller that KEEPS SOLIDS MOVING



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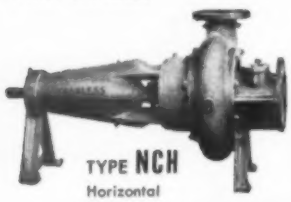
showing unique repelling vanes on outer shrouds.



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Horizontal Sewage Pump

Here is positive non-clog pumping *in action*, as well as name. All wearing rings, end plates, filler rings, etc., have been discarded in the Peerless design, in favor of an improved impeller with unique repelling vanes on both of its outer shrouds. These repelling vanes provide a pumping action similar to the working vanes between the shrouds, preventing accumulation of solids in the space between the impeller and casing side walls by agitating the solids into the center flow of the fluid stream. Specify Peerless Non-Clog Sewage Pumps for trouble-free service and economy in sewage treatment and relift stations. *Request Bulletin B-154.*

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SOUND PRINCIPLES OF WATER TANK MAINTENANCE and TANK TALK, by W. A. RILEY

—SAFETY—SERVICE—SATISFACTION—

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THE LARGEST ORGANIZATION OF ITS KIND GIVING SAFE MAINTENANCE AT LOW COST

and it makes possible for the Board to grant extensions of time to any municipality or industry which is ordered to eliminate or abate its pollution.

In operation the Stream Pollution Control Board will have an executive secretary who will be a member of the State Dept. of Health. The technical staff will be furnished by the State Dept. of Health and the State Dept of Conservation, and any other department which may have an interest in the problem. A mobile laboratory will be established and available for study of various streams and bodies of water in the State.

The development of this proposed act of legislature has followed a two-year study not only of the problems that exist in the State of New York, but also of stream pollution control units and boards and their operations in other states.

The operation of this stream pollution control act is envisaged as approaching the subject in the cooperative manner which has been utilized for the past several years at Buffalo, N.Y., where an industrial waste pollution problem has been under study by the Buffalo Sewer Authority, the State Depts. of Health and Conservation, and the several industries involved.

Contaminated Water Supplies?

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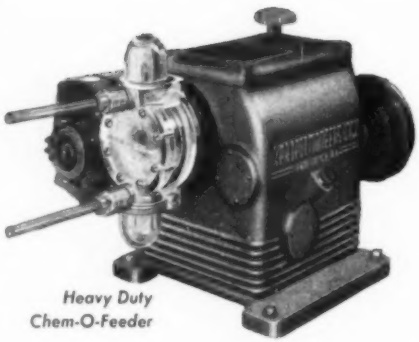
The discovery of harmful organisms and disease germs in your water supply is something to get excited about . . . destroy them by hypochlorination with %Proportioneers% Heavy Duty Chem-O-Feeder — the modern way to protect the health of your community. There's no risk of dangerous undertreatment or the disagreeable taste resulting from wasteful overtreatment. By simply turning a knob, the chemical feeding rate may be instantly adjusted while the pump is operating . . . up to 7 g.p.h. can be fed with extreme precision.

Sterilization of water supplies becomes entirely automatic with the Chem-O-Feeder cross-connected to the starting switch of the main pump motor. No skilled help is required as there is none of the danger that goes with using deadly chlorine gas. The chemical being fed shows plainly in the "See-Thru" plastic head and the action of the check valves and diaphragms is clearly visible. In addition to handling hypochlorite solution, the Heavy Duty Chem-O-Feeder successfully feeds all other water treating chemicals — soda ash, lime slurry, aqua ammonia, activated carbon, sulphates, ferric chloride, polyphosphates, etc.



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For help with your chemical feeding problems write %Proportioneers, Inc.%.

Ask for Bulletin SAN-2.

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MANUFACTURERS' and EQUIPMENT NEWS

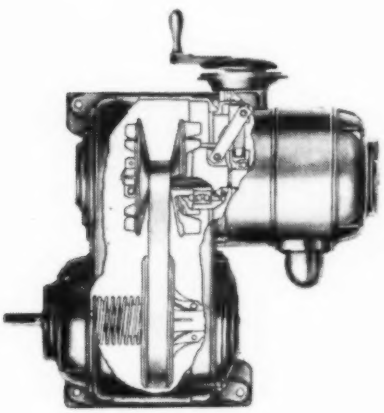
Yeomans' 50th Anniversary

According to a story in the July-August issue of the *Yeomans Guard*, Yeomans Brothers Co. is celebrating its 50th anniversary this year. The story is entitled "A Biography of a Business with the Right Idea," and it recounts the founding of the Company by Edward Yeomans and his brother Charles, now president of the company. The company, located at 1431 N. Dayton St., Chicago 22, Ill., manufactures pumps and pumping machinery, ejectors, clarifiers, package aerifiers, and is a licensee for the aero-filter trickling filter process.

1000

Variable Speed Motor

U. S. Electrical Motors, Inc., 200 Slausen Ave., Los Angeles 54, Calif., has developed a new model Varidrive motor. The Varidrive enables a machine operator to obtain infinite speed. It is shown in the accompanying cutaway drawing.



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During the last 15 or 20 years several million dollars have been spent on hydrologic investigations and the accumulation of hydrologic data. This is the first book to make use of this important material in a systematic study of precipitation and runoff.

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● **important new methods for more exact measurement and prediction of precipitation and runoff**

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Infilco Advances Eidsness, Appoints Starling

Infilco Inc., has announced the appointment of Charles H. Starling as Southeast District Engineer with headquarters in Decatur, Georgia, to replace Fred. A. Eidsness, who will become Philadelphia District Engineer under jurisdiction of Infilco's New York Office.

Prior to his Infilco appointment, Mr. Starling was an engineer with Barnard & Burk, Consulting Engineers, Baton Rouge, La., from 1947 to August of this year. From 1938 to 1947 he worked with Infilco as a Field Engineer.

Mr. Eidsness, an Infilco Field Engineer since 1945, was formerly Sanitary Engineer for the Florida State Board of Health in Jacksonville.

A. C. Monteith Advanced At Westinghouse

A. C. Monteith, engineering executive of the Westinghouse Electric Corp., has been elected Vice President in Charge of Engineering and Research, Gwilym A. Price, Westinghouse President, announced from Pittsburgh. He succeeds Marvin W. Smith whose election as Executive Vice President of Baldwin Locomotive Works was announced.

Mr. Monteith's 25-year electrical engineering career began at the Westinghouse East Pittsburgh Works. He joined the Company in 1923 as a graduate student engineer in the training course, and was assigned to the Central Station Engineering Department in 1924. He became manager of that department in 1938 and in 1941 was named manager of the Industrial Engineering Department. In 1945, he took over the dual position of manager of Headquarters Engineering Department and Director of Education.

DON'T WASTE IT!
WEIGH IT
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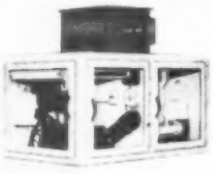
GRAVIMETRIC FEEDERS

The accurate, economical way to feed chemicals is the OMEGA way — *with Gravimetric Feeders.* These sensitive units deliver the exact weight of material required in your water or sewage treatment process. There's no waste — and no skimping, either. You set the feeding rate (variable over a 100 to 1 range) and the Feeder does the rest. OMEGA Feeders can be equipped with dust collectors to help keep your plant tidy in appearance with a minimum of housekeeping and maintenance. Automatic proprotioning controls are available.



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Material is continuously weighed on short conveyor belt carried on sensitive scales.

Widely used with OMEGA Lime Slakers. Feeding accuracy 98% or better, capacity to 10,000 lbs. per hr.

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Loss-in-Weight Type
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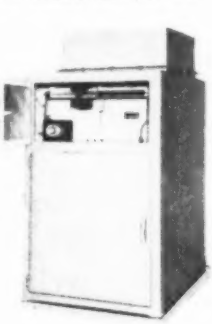

has hopper mounted on sensitive scales. Feeds any dry material, ½ to 5000 lbs. per hr., with accuracy of 99% or better.

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1001

Rubber Packing Gasket

Northrop & Co. Inc., Spring Valley, N. Y., is now furnishing the new BOND-O Rubber Packing Gasket. The gasket, pictured here, is cut for sizes 4 to 14 in. pipe and will provide bacteria-free packing for bell and spigot cast iron water mains.

This scarf joint caulks easily, requiring about one-quarter of the time for caulking jute, and can be used for new work, for maintenance where an existing joint must be replaced without removing the spigot from the bell or for wet joints. Being rubber and harboring no bacteria, disinfecting new laid pipe with this gasket is surer and cheaper than where jute is used. This new gasket may be used with any type of jointing compound as well as lead.

For further information use a Reader Service Card on which is entered the above key number and your name and address.

Another Great PUMP "by Aurora"

WINS RESPECT THROUGH PERFORMANCE

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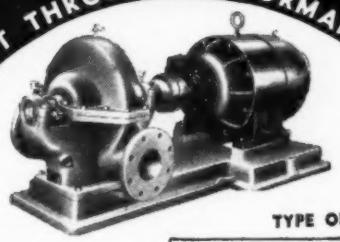

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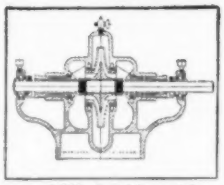

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MIXED FLOW
SPECIAL DESIGN
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Available in capacities to 4,000 G.P.M. and heads to 300 ft., these accessible, compact, and lasting Type OD Pumps are widely used for general water supply, for municipalities, industrial plants, office buildings, institutions. Also for handling condenser circulating water, wash water, liquids in paper mills and distilleries, chemical solutions, oil in oil fields and refineries, irrigation, etc.

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For control of more than three circuits, ask for Bulletin S-7 on SELECTROL.

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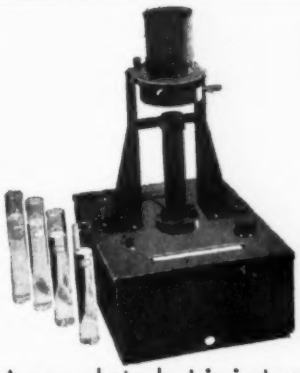

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Photoelectric Colorimeter Model 450 for Nessler Tubes

A new photoelectric instrument of high accuracy for the measurement of color and turbidity, as well as for all analytical colorimetric tests in the examination of water and sewage.

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- Suited for determination of ammonia nitrogen, nitrate, nitrite, and for all other colorimetric tests according to APHA "Standard Methods."
- Operates with all "low form" Nessler tubes 32 mm O.D., 200 mm high. Requires no matched sets or tubes.

LUMETRON Mod. 450 eliminates the uncertainties of visual matching methods. It requires no permanent color standards and furnishes reproducible results independent of individual judgment and of light conditions.

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Alhydro FLOC PRODUCER

FOR INDUSTRIAL OR MUNICIPAL WATER TREATMENT PLANTS AND SWIMMING POOL INSTALLATIONS

"It's the answer to turbidity and color removal"

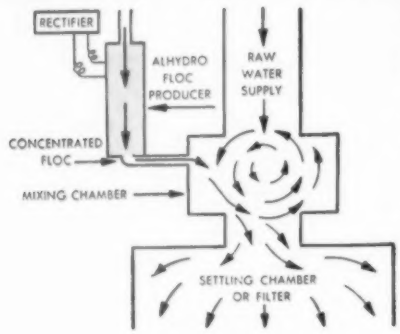
"Right! The most efficient formation of stable floc yet"

The Alhydro Floc Producer assures continuous production of a readily controllable concentration of aluminum hydroxide floc. And Alhydro floc is completely stable . . . will re-form immediately if broken up by pipes or pumps.

The Alhydro unit uses only aluminum plates and low voltage direct current to form the floc. Thus, it makes 69 lbs. of aluminum treat as much water as nearly ¾ ton of ordinary coagulants . . . solves the problem of chemical storage.

Simple to operate, easy to maintain, one unit measures only 45″ x 13″ x 34″, and will treat an average of 300,000 gallons of water per day. The Alhydro unit may be installed singly or in multiples, in existing or proposed water treatment plants.

This installation of ALHYDRO FLOC PRODUCER in your water treatment plant will provide you with . . .



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This folder describes and illustrates the operational advantages of the Alhydro Floc Producer. See how you can simplify the treatment of drinking water or water for industrial use. Write for free copy today.

ALHYDRO, INC. DEPARTMENT 108 516 N. CHARLES ST., BALTIMORE 1, MD.

Rimback Joins Liquid Conditioning

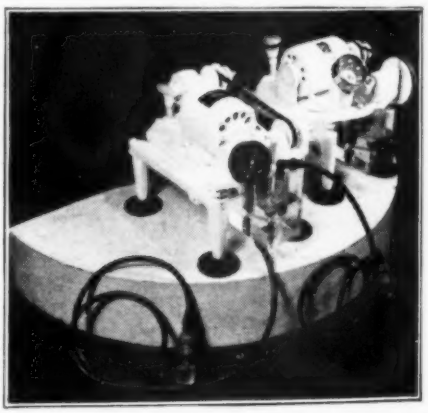
The Liquid Conditioning Corp. of Linden, N.J., has announced the appointment of T. N. Rimback as District Manager for the territory com-

prising the states of Missouri and Arkansas, the eastern part of Kansas and the southern part of Illinois. A graduate of M.I.T. in 1934, Mr. Rimback has been associated with the Permutit Co. for a number of years. His new headquarters will be at 3903 Olive Street, St. Louis 8, Mo.

1002

Majax Kem-Pumps

Majax Co. Inc., 601 South 1st St., Waco, Texas, has introduced a new line of proportional chemical feeders called Kem-Pumps. This new pump which includes a tachometer control for gaging feed has a rolling gland displacement device. This device substitutes a sheet of water as a seal instead of a diaphragm common to most chemical feeders. This makes



piston packing unnecessary. Linear "O" rings make it possible to perform these functions by their use as piston rings with adjustable diameter which compensates for wear and pressure changes. The "O" rings roll on a sloping groove rather than sliding with friction as in their previous comon usage.

For further information on this item use a Reader Service Card on which is entered the above key number and your name and address.

COMPARE O. S. C. SEPTIC TANK CLEANING

WITH OLD FASHIONED, UNSANITARY METHODS

When a Sanitary Service Operator puts a new Gorman-Rupp Odorless Sanitary Cleaner on the job these are the results:—

1. A disagreeable job becomes pleasant, easy work.
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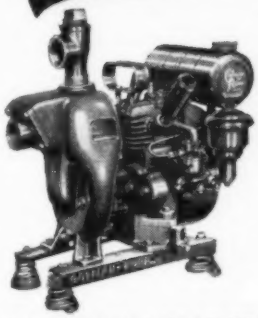
3. It does each job more thoroughly, in a fraction of the time previously required. For example, 500 gal. tanks are cleaned in 15 minutes, 1000 gal. tanks in 20 minutes.
4. It offers operators profit possibilities far in excess of income with present equipment and methods.
5. An O. S. C. unit has other profitable uses such as transporting water, emergency fire fighting, sprinkling, dewatering, etc.

Show this to Sanitary Service Operators in your community. For complete information write for Bulletin 7-ST-11.



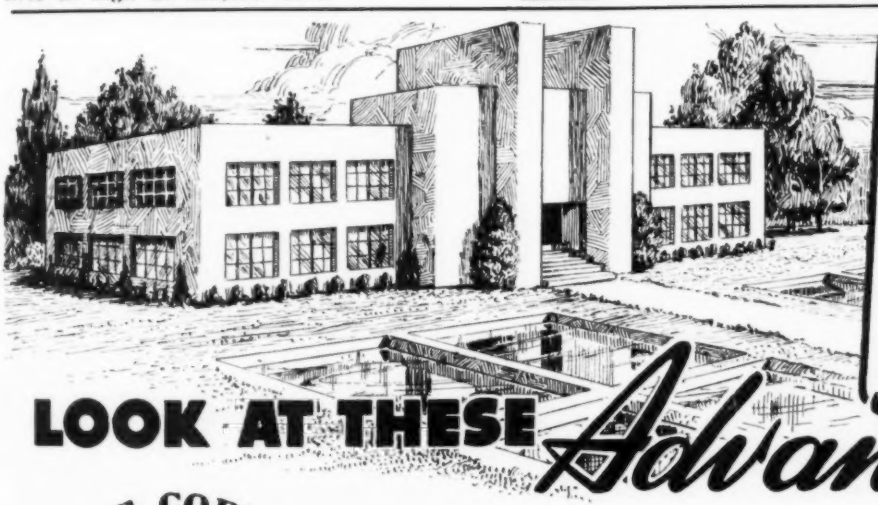
GORMAN-RUPP'S NEW "MIDGET" 1½" PUMP

FASTEST, self-priming, most efficient pump for general use. Weighs but 62 lbs. -- pumps 5500 GPH -- self-primes up to 30 ft. -- non-clogging, sturdy. Gorman-Rupp builds a complete line of pumps from the "HANDY", delivering 8 GPM, to large capacity pumps which deliver as high as 125,000 GPH.

327 NORTH BOWMAN STREET.

THE GORMAN-RUPP COMPANY

MANSFIELD, OHIO



Write for New Booklet

This book contains information, charts, diagrams, etc., as well as general information on the advantages to be obtained with FERRI-FLOC.

TENNESSEE CORPORATION
Grant Building Atlanta, Ga.

LOOK AT THESE *Advantages...*

TENNESSEE CORPORATION
Ferri-Floc
FERRIC SULPHATE

As Summarized By a Prominent Professor of Chemistry and Water Consultant of a Large University

Coagulation is effective over a much wider pH range than with other coagulants. Color flocs may be formed in the very acid range. On the other hand, true hydrated ferric oxide flocs may be formed at pH 9-10, or even higher, for the removal of turbidity and manganese.

The time required for floc formation, conditioning, and settling is in most cases considerably shorter than that required for other coagulants.

Filter runs have been markedly increased in most cases.

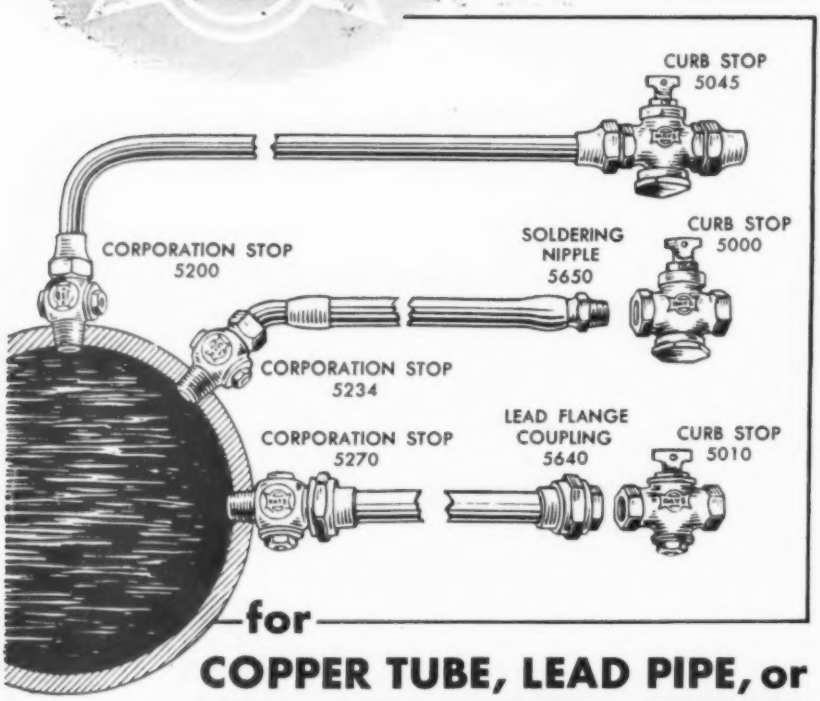
Manganese is successfully removed at pH values above 9.

Effluents may be produced which are exceedingly low in both iron and aluminum.

Ferric floc does not seem to stick to sand grains to form mud balls, and is subject to less "breaking through" on the filters.

TENNESSEE CORPORATION
Atlanta, Georgia — TENNESSEE CORPORATION — Lockland, Ohio

HAYS CORPORATION and CURB STOPS



for COPPER TUBE, LEAD PIPE, or IRON PIPE WATER SERVICE

HAYS water service products are installed in all parts of the world. The Hays Manufacturing Company is one of the largest in its field, and high quality has been maintained throughout the eighty years of its life.

Only the highest quality water works bronze (85-5-5-5) is used. Every fitting is precision machined and hydrostatically tested at 200 pounds or more. All curb and corporation stops are specially lubricated for easy and enduring operation.

HAYS corporation stops can be installed with any standard tapping machine equipment and all water works fittings are interchangeable with other makes.

Ask for our new complete catalog of water service products.

HAYS COPPER · BRASS · LEAD · IRON
WATER WORKS PRODUCTS
HAYS MANUFACTURING CO., ERIE, PA.

MECHANICAL EQUIPMENT BY ROBERTS FILTER MFG. CO. DARBY, PENNA.

KNOWN AROUND THE WORLD AS THE SIGN OF EXCELLENCE IN WATER TREATMENT EQUIPMENT

The years of experience behind the Roberts nameplate is your assurance that any water rectification problem is expertly handled to your best advantage. As manufacturing and installation engineers, the Roberts organization is equipped to meet your exact needs regardless of the size of the equipment or the complexity of the problem.

GRAVITY FILTERS • SOFTENING PLANTS AND EQUIPMENT • PRESSURE FILTERS ZEOLITE SOFTENERS • SWIMMING POOL RECIRCULATING APPARATUS SPECIAL WATER TREATMENT EQUIPMENT

We invite your inquiries

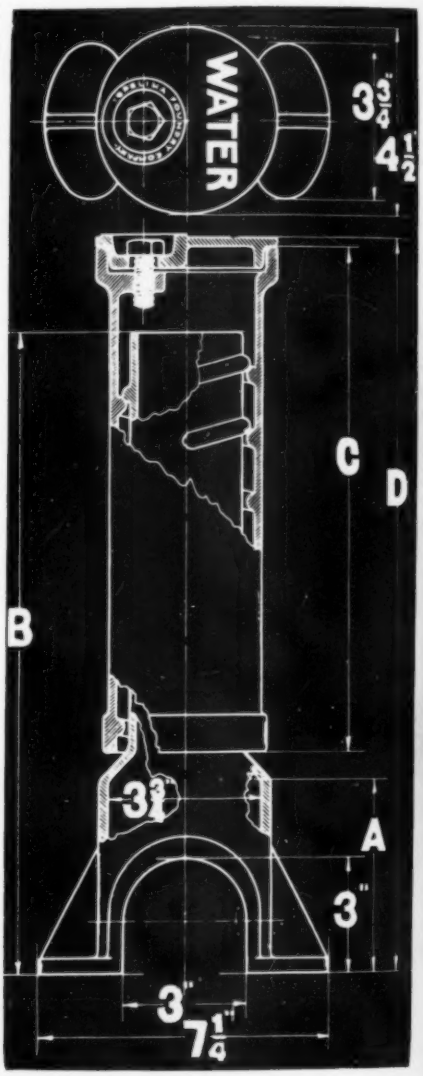
ROBERTS FILTER MANUFACTURING COMPANY • *Darby, Pa.*

1003

Curb Boxes

The Opelika Foundry Co., Opelika, Alabama, has recently developed a new method of manufacture of the 2½ in. Cast Iron Service or Stop Boxes which are now available.

The new style service boxes can be furnished with either water or gas covers which are fastened to the top section of the box by means of pentagon head manganese bronze screws.



The design as shown in the illustration is unique in that the sides of the top sections are straight and lend strength to the box. The bottom sections have large bells, re-enforced with properly designed ribs, to provide ample space for the curb cock.

If you desire further information on this new style service or curb box enter the above key number on a Reader Service Card together with your name and address and mail.

READER SERVICE CARDS for

WATER & SEWAGE WORKS

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Information — Literature

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WATER & SEWAGE WORKS READER SERVICE

READER SERVICE CARDS HOW TO USE THEM

Please fill out a separate coupon for each item on which you desire information. This will greatly facilitate handling.

Key number is at head of each new product, item of equipment, catalog or bulletin, described in this issue.

Enter key number in box.

Please PRINT your name and title, company or department name, and your address

NOTE—

These cards are to be used only for items described in THIS ISSUE

WATER & SEWAGE WORKS

Will see that you receive information desired.

Rugged Quality
Plus Planned Efficiency

--MORE YEARS OF SERVICE

There is more genuine old fashioned quality in Layne Well Water Systems than today's buyer has a right to expect. We've been building them for over sixty-five years and know that every little gadget must be tough enough to last. But right along with quality we have constantly improved efficiency—stepping it higher and higher.

Just put those two factors together—quality and efficiency and demand them in your Well Water System, and you'll end up by owning a Layne.

It isn't as if we had built only a few Layne Well Water Systems that happened to turn out pretty good. For many years we have been building them for a world wide trade; Europe, India, Africa, Indo China, Mexico, Venezuela, South American Countries, Canada and hundreds for the United States.

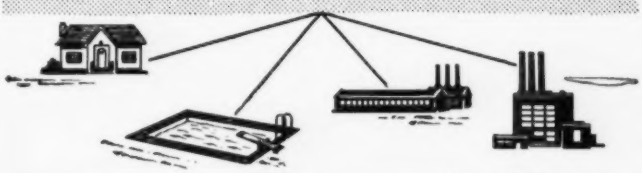
A lot of cities, railroads and industries of all kinds use Layne Well Water Systems exclusively and will consider no other kind. They seem to know that they are getting a mighty big dollar's worth of real value.

For further information, catalogs, bulletins, etc., address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

LAYNE
WELL WATER SYSTEMS

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc. Seattle, Washington ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Minnesota Co., Minneapolis, Minnesota ★ International Water Supply Ltd., London, Ontario, Canada ★ Layne-Hispano Americana, S. A., Mexico, D. F.

SOFT CLEAR IRON-FREE WATER
is becoming a "municipal must"



and here's why you should use the LIQUON way

If your present water softening and clarifying treatment is unsatisfactory or uneconomical . . . consult LIQUON.

If you are planning extensions to your water treating plant to take care of increased requirements . . . consult LIQUON.

If your community does not yet have soft, clear, iron-free water . . . consult LIQUON.

BECAUSE . . .

LIQUON processes include *every* method of water treatment.

LIQUON equipment designs embody the latest developments of proven performance.

LIQUON engineers and chemists have initiated many of the accepted advances in water treatment and are recognized authorities in this field.

LIQUON recommendations are based on more than 30 years of experience in specializing on water problems.

Your request for LIQUON advice will not involve any obligation on your part, and will assure the most modern, effective and economical treatment of your water supply.

Send the coupon for full information.

LIQUID CONDITIONING CORPORATION

114 East Price Street, Linden, N. J.

Engineering Service Representatives in Principal Cities

Liquid Conditioning Corp., 114 East Price St., Linden, N. J.

Please send me information on water treating equipment for municipalities without obligation to me.

NAME .....

POSITION .....

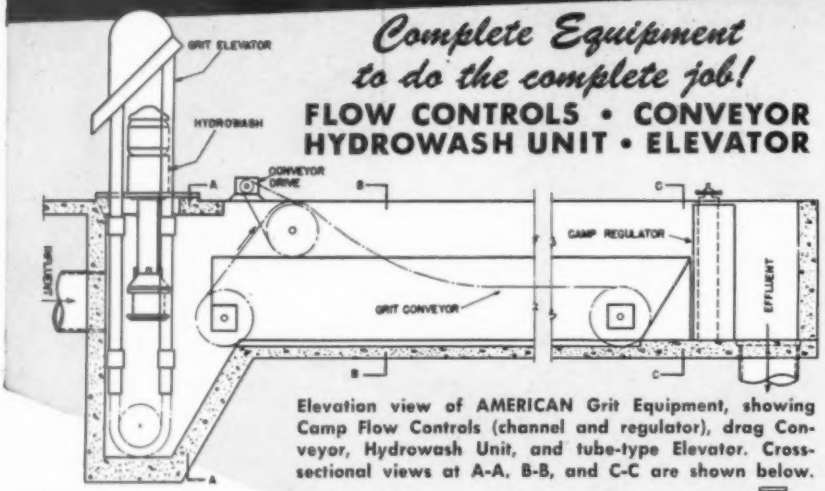
ADDRESS .....

WSW-10-48 .....

REMOVE GRIT
EASILY... THOROUGHLY... AT LOW COST!

Complete Equipment to do the complete job!

FLOW CONTROLS • CONVEYOR HYDROWASH UNIT • ELEVATOR



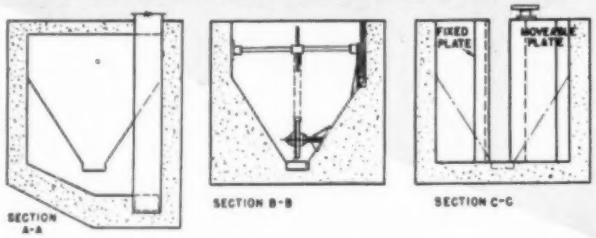
Elevation view of AMERICAN Grit Equipment, showing Camp Flow Controls (channel and regulator), drag Conveyor, Hydrowash Unit, and tube-type Elevator. Cross-sectional views at A-A, B-B, and C-C are shown below.

PROVIDES CONSTANT OPTIMUM VELOCITY

POSITIVE ADJUSTMENT FOR VARYING FLOWS

HYDRO-DYNAMIC WASHING

AUTOMATIC DRAINING AND REMOVAL



FLOW CONTROLS—exclusive Camp Control Section and Regulator maintain constant optimum velocity for effective grit settling, regardless of rate of flow through plant. Velocity can be easily and instantly adjusted to meet changing conditions.

CONVEYOR—single strand, continuous drag type carries grit from channel to hopper for washing and removal.

HYDROWASH UNIT—washes grit free of organic matter by producing a turbulent downflow recirculation of liquor in grit hopper.

ELEVATOR—totally enclosed, tube type, for slow and continuous removal of washed grit from the hopper. Grit drains as it is being elevated through the tube.

Write for Bulletin No. 249A

Our staff of Sanitary Engineers will cooperate with consulting and operating engineers in suggesting the process of treatment and type of equipment best suited to individual needs.

AMERICAN WELL WORKS

IN OUR 80TH YEAR
101 North Broadway
AURORA, ILLINOIS

Pumping, Sewage Treatment, and Water Purification Equipment
RESEARCH · ENGINEERING · MANUFACTURING

Offices: Chicago • New York • Cleveland • Cincinnati • Kansas City • Sales Representatives throughout the World

AMERICAN GAS BOILERS
STEAM AND WATER TYPES

FOR DIGESTER HEATING

American Radiator & Standard Sanitary Corporation, Pittsburgh, Pa.

SALES OFFICES IN PRINCIPAL CITIES

FOR RATINGS AND DATA SEE OUR PAGE IN THE ANNUAL REFERENCE SECTION

AMERICAN-Standard
First in Heating and Plumbing

W. E. Bisler Represents Flexible Sewer-Rod

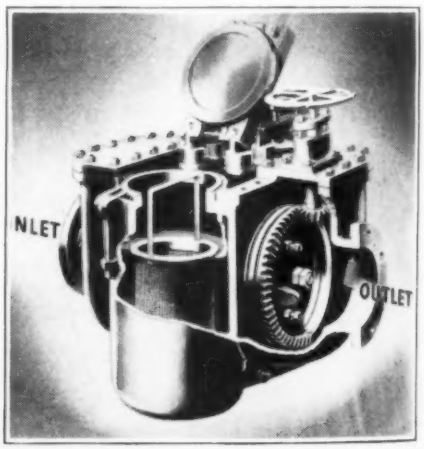
Flexible Sewer-Rod Equipment Co., and Flexible Under Ground Pipe Co., of Los Angeles, California, has announced the appointment of Walter

E. Bisler, as the representative in the western Pennsylvania and West Virginia area. Mr. Bisler's headquarters will be at 909 North Homeward Ave., Pittsburgh, Pa.

1004

Duplex Strainer

R-S Products Corp., Philadelphia 44, Pa., has developed a new R-S duplex strainer to assure clean water. Utilities and industrial plants which need clean water will find this R-S duplex strainer effective and of simple design. Single hand wheel control by only 2½ turns permits alternate

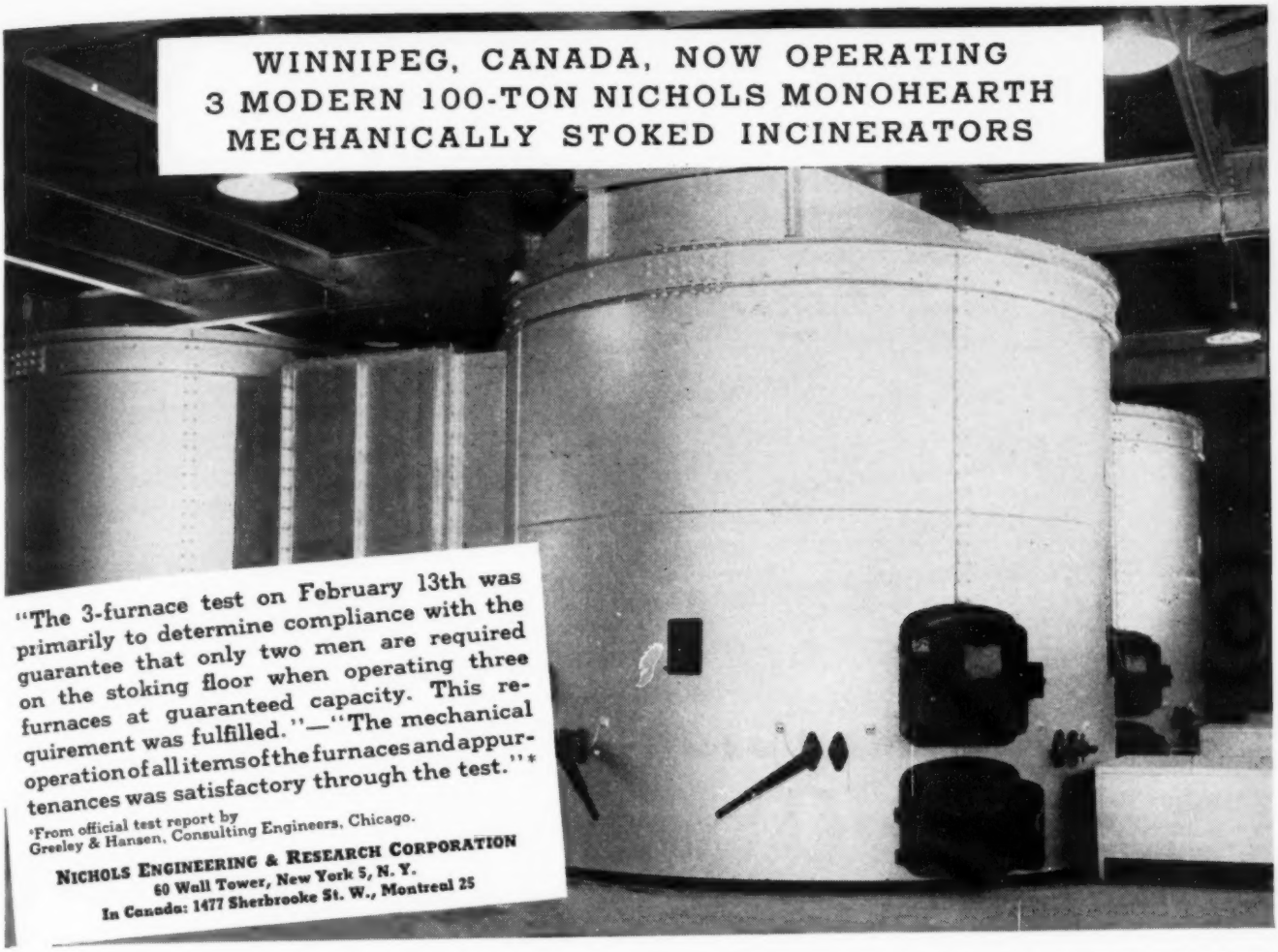


removal of identical basket strainers without interruption of the flow, thereby giving an advantage to the old-style 2 wheel control involving complete shut-off.

Four to 24-inch pipe sizes are available and the pressure loss is extremely low. The ratio of straining area in each compartment to the area of the inlet is approximately 3 to 1.

For further information on this unit enter the above key number on a Reader Service Card and mail.

WINNIPEG, CANADA, NOW OPERATING
3 MODERN 100-TON NICHOLS MONOHEARTH
MECHANICALLY STOKED INCINERATORS



"The 3-furnace test on February 13th was primarily to determine compliance with the guarantee that only two men are required on the stoking floor when operating three furnaces at guaranteed capacity. This requirement was fulfilled."—"The mechanical operation of all items of the furnaces and appurtenances was satisfactory through the test."*

*From official test report by Greeley & Hansen, Consulting Engineers, Chicago.

NICHOLS ENGINEERING & RESEARCH CORPORATION
60 Wall Tower, New York 5, N. Y.
In Canada: 1477 Sherbrooke St. W., Montreal 25

Modernize—Powerize—Economize!

7 Power Sewer Cleaning Units *Offered by* TURBINE

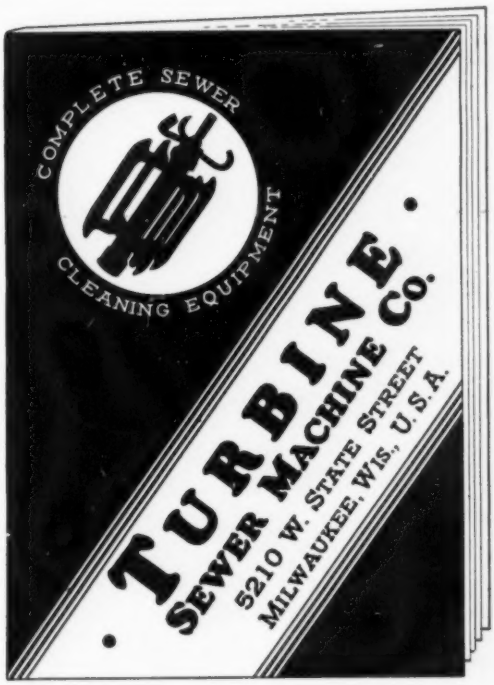
TURCO MAXI-POWER UNIT NO. 2

Models
VF3—Water-Cooled
ZF3—Air-Cooled

Write for this catalog and get Maxi-Power specifications.

EXCLUSIVE FEATURES:

1. Tubular frame
2. Forged, inclosed gearing
3. One clutch
4. Flange ball-bearings
5. Designed level wind
6. 3-speed transmission
7. High-speed chain drive
8. No-clutch free spooling
9. Selected speeds
10. Bucket swing positioner



Royer machine at Monroe, Michigan, turning waste sludge into profitable fertilizer.

56% Moisture Content Sludge Cake turned into marketable soil-conditioner with a ROYER Sludge Disintegrator

Sludge cake (up to 56% moisture) can be taken right from the sludge beds . . . shoveled into a Royer, along with an added chemical fertilizer, if desired, which discharges a finely granulated, thoroughly mixed fertilizer material directly into trucks or bags. Easy! Low cost! And . . . highly profitable, because Royerated sludge is worth good money to farmers, florists, golf courses and parks. Get all the facts. Send for Royer Sewage Sludge Datalog.

ROYER

PIONEERS IN THE SALVAGE OF SEWAGE SLUDGE

ROYER FOUNDRY & MACHINE CO.
170 PRINGLE ST., KINGSTON, PA.

MAKES WATER BRIGHT
AND BETTER TASTING TOO!

STUART CORPORATION BALTIMORE

CONTRACTORS OF PUBLIC WORK
SPECIALIZING IN
PALMER SURFACE WASH SYSTEMS
AND
KWIK-WAY FLOCCULATION SYSTEMS

ESTIMATES NO OBLIGATION

STUART CORPORATION · 516 N. CHARLES ST., · BALTIMORE 1, MD.

T. S. Nichols Chairman Mathieson Board

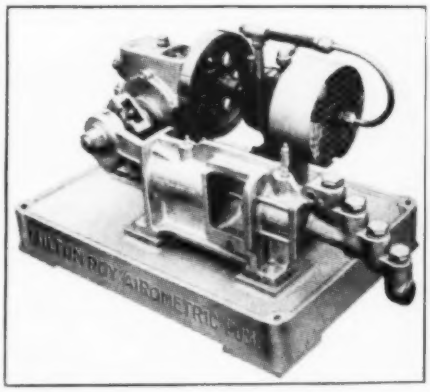
The Board of Directors of Mathieson Chemical Corp. has elected Thomas S. Nichols, President and Chief Executive Officer, to the additional post of Chairman of the Board to succeed the late George W. Dolan.

J. C. Leppart, Vice President, was elected a member of the board to fill the vacancy caused by Mr. Dolan's death, and was appointed executive vice president.

1005

Air Motor Drive Chemical Pump

Milton Roy Co., 1329 E. Mermaid Rd., Philadelphia 18, Pa., has developed, for use where electric power is not available, a new chemical pump, in Simplex and Duplex models, powered by a 1 hp. rotary air motor. This "Airometric" Pump is operated by natural gas or compressed air as the prime mover, at air pressures from 50 to 80 psi. A pressure regulator and indicating gage are supplied with each unit to reduce the supply pressure to that required for pump operation. Maximum motor speed is 1750 rpm., held constant by a governor which



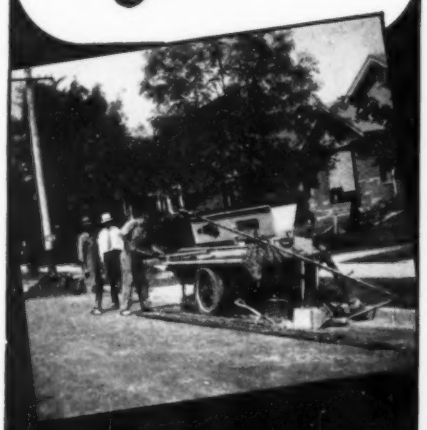
throttles the air exhaust from the motor. Drive is through a speed reduction unit. The motor and mechanical system are balanced by means of a fly-wheel fixed to the motor coupling.

Applications include the pumping of chemicals in controlled volume and in small quantities, the handling of difficult or corrosive materials, pumping chemicals into flowing oil wells to minimize corrosion, pumping treating chemicals into boilers or boiler feed water lines or any other purpose where a chemical pump is required and electric current is not available.

For further information mail a Reader Service Card on which is entered your name and address and the above key number.

PORTABLE
All Steel
TOOL
BOX

THIEFPROOF
WEATHERPROOF
FIREPROOF



Littleford "Handeebox" All Steel Tool Box is constructed to trail at high speed—in addition, it is light weight, neat in appearance, sturdily built, has patented all around locking arrangement, wide working shelves on both sides, partitions and shelves for tools, etc. Gas, Waterworks, and Sewage Departments and contractors will find this "Handeebox" the low cost method of transporting valuable tools to the job—and too, the "Handeebox" can stay on the job overnight without fear of losing valuable tools. Ask for Bulletin V-6.

LB LITTLEFORD
Littleford Bros., Inc.
420 E. Pearl Street, Cincinnati 2, Ohio

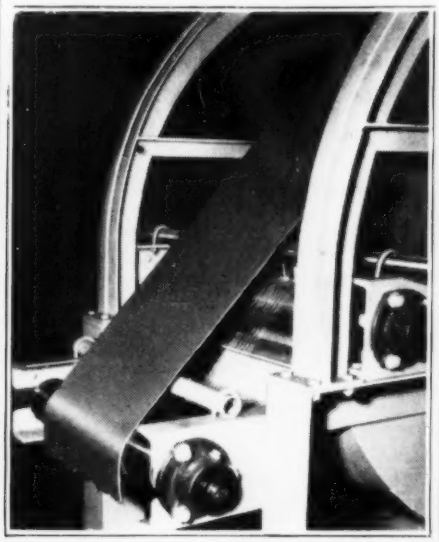
Jeffrey Expands Operations

The Jeffrey Co., of Columbus, Ohio, has recently purchased the Case Crane & Kilbourne Jacobs Co., also located in Columbus, Ohio. The latter company has operated for 36 years and is engaged in engineering for the fabrication of structural steel for buildings and bridges. The recently acquired firm is located adjacent to the Jeffrey plant, and will operate as a subsidiary of The Jeffrey Co. with no changes in management or policies contemplated.

1006

Continuous Vacuum Filter

Filtration Engineers Inc., 858 Summer Ave., Newark 4, N.J., has announced a new, small, continuous FEinc vacuum filter for use in the disposal of pickle liquor. The filter is used in conjunction with any waste-neutralizing process which results in the precipitation of iron oxides and other solids in neutralized solution. Following joint research with steel mills, the company announces that this

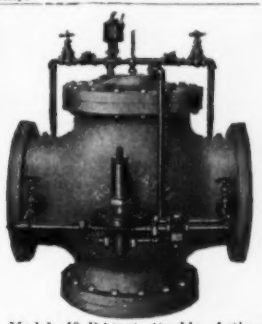


continuous filter will separate the solids and allow the clear filtrate to pass on into the streams without the danger of acid pollution. The filter is a special adaptation of the FEinc String Discharge Filter. It has a filtering rate from 60 to 600 lbs. of dry solids per hour, depending on the nature of the waste liquor and type of neutralizer used. The cake will contain from 55 to 75 percent moisture, and can be easily handled by conveyor or truck.

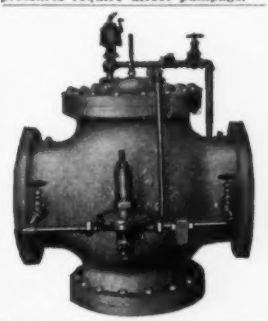
For further information on this unit, designed for particular waste treatment problems, enter the above key number on a Reader Service Card and mail.

Est. 1879
ROSS
AUTOMATIC
VALVES

Altitude Valves for tank and reservoir, with two sets of controls—Automatic Hydraulic and Electric Remote Control. Hydraulic pilot normally operates the valve, while electric pilot is used for emergency only.



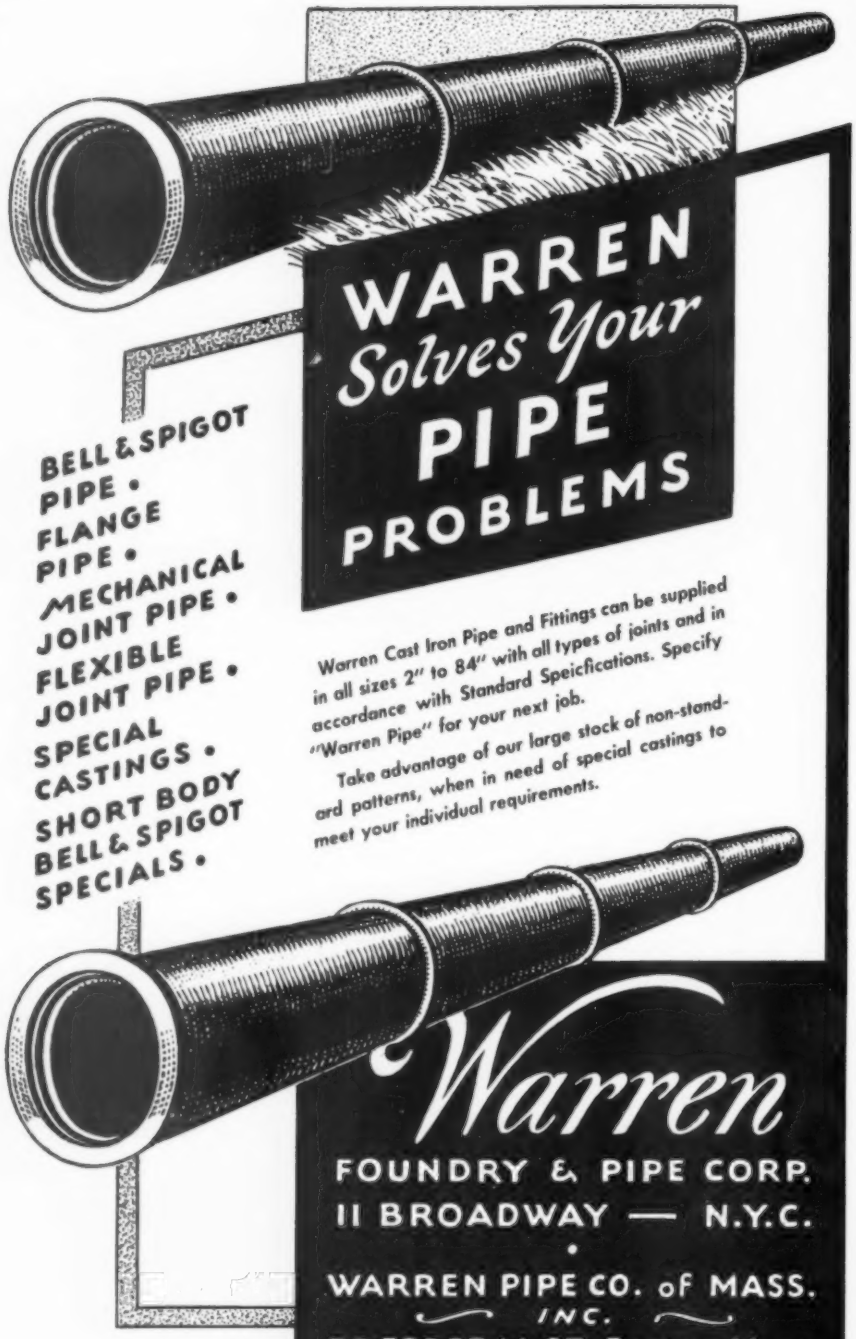
Model 40-DAWR Double Acting may be operated by electric pilot regardless of elevation of water in tank or reservoir, for a break in supply or distribution and when fire pressures require direct pumpage.



Model 30-AWR Single acting valve may be controlled in same manner as the Model 40-DAWR.

Model 40-AWR Single Acting semi-throttling valve will close on reversal of flow and the electric pilot would serve only a single purpose—either to open wide or close as emergency may require.

ROSS VALVE MFG. CO.
Incorporated
P.O. BOX 595, TROY, N.Y.



WARREN
Solves Your
PIPE
PROBLEMS

BELL & SPIGOT PIPE • FLANGE PIPE • MECHANICAL JOINT PIPE • FLEXIBLE JOINT PIPE • SPECIAL CASTINGS • SHORT BODY BELL & SPIGOT SPECIALS •

Warren Cast Iron Pipe and Fittings can be supplied in all sizes 2" to 84" with all types of joints and in accordance with Standard Speicfications. Specify "Warren Pipe" for your next job.

Take advantage of our large stock of non-standard patterns, when in need of special castings to meet your individual requirements.

Warren
FOUNDRY & PIPE CORP.
11 BROADWAY — N.Y.C.
•
WARREN PIPE CO. of MASS.
INC.
75 FEDERAL ST., Boston, Mass.

W. G. Kaiser, Asst. Dir. Promotion, P.C.A.

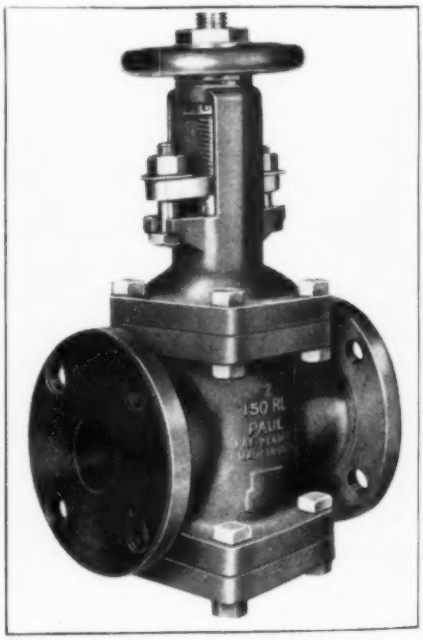
W. G. Kaiser, Manager of the Portland Cement Association's Farm Bureau, has been appointed Assistant Director of Promotion, according to an announcement by Frank T. Sheets, Association President. T. E. Long, Assistant Manager of the Farm Bureau, succeeds Mr. Kaiser as Manager. Both promotions became effective August 1.

In his new capacity Mr. Kaiser will work with W. D. M. Allan, Director of Promotion, giving special attention to the Association's advertising, public relations and literature production activities.

1007

Ace-Lined Paul Valve

The American Hard Rubber Co., 11 Mercer Street, New York, has announced that the new Paul "Straight-Through" Valve is now available lined with Ace Hard Rubber, thus becoming corrosion resistant. The Paul valve is self-flushing, and of simple



design, and operates on the Bernoulli Theorem that "an object placed on the edge of a stream tends to move to the high velocity, low pressure, center of that stream." In the case of the Paul Valve the "object" is a hard rubber ball which is the "disc" of the valve, and which rises to close the valve. This same principle raises the dirt, scale and solids into the center of the stream and flushes them out. The valve is easily opened.

For further information on this unique valve enter the above key number on a Reader Service Card.

BAILEY METERS
AND CONTROLLERS
FOR SEWAGE TREATMENT
AND WATER SUPPLY . . .

BAILEY METERS

● Venturi Tubes, Weirs, Flumes, Nozzles and other primary elements; Mechanically and Electrically operated Registers and Complete Automatic Control Systems.

BAILEY METER COMPANY
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Bailey Meter Co. Ltd., Montreal, Canada

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ALBERT PIPE
SUPPLY COMPANY, INC.
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1008

Laboratory Colloider

The Colloid Equipment Co., of 50 Church Street, New York 7, N.Y., is offering a new laboratory mixer. Known as the Whiz-Mixer, this unit will emulsify, macerate, or disperse solids and liquids. It is in effect a laboratory colloider. The unit is operated by a two speed motor 1/5 hp., is durable, non-tarnishable, non-breakable, and acid resistant, with stainless steel bowl and cover. Cutting knives are stainless steel. It is obtainable in

a one quart capacity size with an overall height of 14 inches, and a weight of 8 lb.

This is the type of unit which has been effectively used in sewage laboratories for improving the suspended solids determination and the B.O.D. test. By proper operation large solids can be broken down to give better sampling for both tests.

Further information on this unit may be obtained by using the Reader Service Card and entering the above key number.

Smith Asst. Mgr. Dorr's No. Amer. Sales Div.

William E. Smith has been promoted to the position of assistant manager of the Dorr Co. No. Amer. Sales Division with headquarters in New York. Mr. Smith has been associated with the company since 1924 and for the last 17 years has been manager of its Canadian division in Toronto. He has been succeeded as manager in Canada by Cyril Hewson Knight, a member of the company's Canadian Division since 1936.

CEMENT GUN COMPANY

"GUNITE" CONTRACTORS

GENERAL OFFICES—ALLENTOWN, PENNA., U.S.A.

RESERVOIR RELINED WITH "GUNITE"

The reservoir pictured at the left is at Hellertown, Penna. This old reservoir was originally lined with concrete which was badly cracked and disintegrated, resulting in serious leakage.

In 1945 we were awarded a contract to reline this reservoir with 2″ mesh reinforced "GUNITE" with the result that the reservoir is now water-tight and better than new.

The upper photo shows the reinforcing mesh in place and the nozzle in operation. The lower photo shows the completed "GUNITE."

Our 72-page bulletin C2300 describes scores of "GUNITE" jobs. Write for your free copy.

MANUFACTURERS OF THE "CEMENT GUN"

COAGULATE WITH N-SOL

Plants with high turbidity water use N-Sol (activated silica sol) to solve the problem. N-Sol coagulant aid produces larger, denser floc which results in filtered water with the sparkle of spring water. N-Sol is prepared conveniently in your plant with "N"® Silicate. Get samples of "N" and directions for jar tests to prove N-Sol efficiency.

® *Phila. Quartz Co.*

PHILADELPHIA QUARTZ COMPANY
1166 Public Ledger Bldg., Phila. 6

N-Sol-A† — N Silicate reacted with ammonium sulfate. Used where chloramine sterilization is desired.

N-Sol-B — N Silicate reacted with alum. (U. S. Pat. 2310009)

N-Sol-C* — N Silicate reacted with Chlorine. The residual hypochlorite retains the same oxidizing powers produced by normal chlorine sterilization.

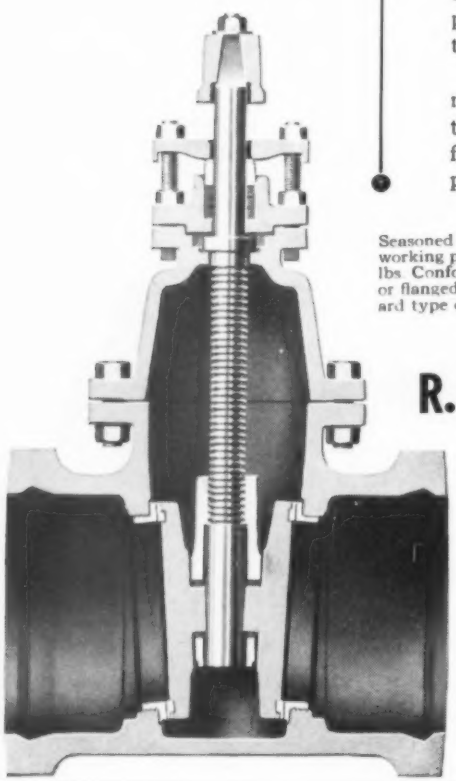
Baylis Sol — N Silicate reacted with sulphuric acid. (U. S. Pat. 2217466)

N-Sol-D — N Silicate reacted with sodium bicarbonate.

†*U.S. Pat. 2,444,774*
**Pat. Applied For*

N-SOL PROCESSES FOR WATER COAGULATION

R. D. WOOD GATE VALVES are designed to WORK



IT DIDN'T JUST HAPPEN that there are so many R. D. Wood Gate Valves in the world. A gate valve is something to be selected with caution. For on some all-important day, it must *work*. Time has built up a universal confidence in the R. D. Wood—that's why there are so many of them.

There are no complicated elements to an R. D. Wood. Three precision-moving parts—discs and spreader,—make up the internal mechanism. Free to rotate on the trunnions while raised or lowered, the discs escape wear in any one place. In opening, they move clear of the seats before being lifted. In closing, they are pushed from center—eased into their brass seats with even, leakproof tightness. The valve fully opened permits unobstructed flow of water. There is no place for sediment to collect or scale to form.

The time could come when your community will desperately need the protection of gate valves that *work*. For the fullest security choose the faithful, time-proved R. D. Wood.

Seasoned castings. Rigidly inspected. For working pressures up to 175 lbs. Tested to 300 lbs. Conforming to AWWA specifications. Bell or flanged ends, or to connect with any standard type of joint. All sizes 2" to 30".

R. D. WOOD COMPANY

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DIAPHRAGM PUMPS

Hand Sizes 2", 2½", 3", 4"
Power Sizes 3" and 4"
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A Filter Medium For All Purposes

ANTHRACITE EQUIPMENT CORP.
Anthracite Institute Building
Wilkes-Barre, Pa.

All correspondence regarding sales and engineering should be addressed to:

PALMER FILTER EQUIPMENT CO.
822 E. 8th St. Erie, Pa.
Engineers and Sales Agents

Jeff Corydon With Majax in Waco

Jeff Corydon II, well known engineer in the field of chemical proportion pumps and particularly for his many years with %Proportioneers%, Inc., has been retained as Consultant to the Majax Co., manufacturers of water conditioning equipment in Waco, Texas. Mr. Corydon has been retained by the company to aid in developing and promoting the new Kem-Pumps being manufactured by the company.

LITERATURE AND CATALOGS

1009

HYPO-CHLORINATION OF WATER

Mathieson Chemical Corp., 60 E. 42nd St., New York 17, N. Y., has published a 6th edition revised and enlarged, of their book on **Hypo-Chlorination of Water.**

This 48-page bulletin is devoted to a discussion of the use of hypochlorite in water treatment. The first chapter deals with water treatment in general, the second with chlorinating for safety. Other chapters contain useful information on sterilizing new equipment, chlorination practices, emergency conditions, control of algae, taste and odors, dosage tables, and analytical determinations.

If you desire a copy of this very interesting bulletin, just enter the above key number on a Reader Service Card and mail.

1010

TRENCH LOADING TABLES

A new 28-page booklet of **Trench Loading Tables** is now available through courtesy of the Robinson Clay Products Co., Akron 9, Ohio. Complete reference tables provide adequate data and a quick, easy method of predetermining loads and strength requirements for clay pipe. Tables show the estimated load according to pipe size, trench depth and width and type of backfill. Trench loads on pipe were computed by the widely recognized, standard "Marston" formula.

For further information use a Reader Service Card on which is entered the above key number and your name and address.

FREE WRITE FOR THIS BOOK BY DR. HALE
Tells How To
CONTROL ALGAE

... AN AUTHORITATIVE WORK CONCERNING THE CONTROL OF MICRO-ORGANISMS AND ELIMINATION OF TASTES AND ODORS. This enlarged edition, by Dr. Frank E. Hale,* describes in detail methods of controlling various forms of microscopic life commonly dealt with in water supply systems. Descriptive material includes 48 clear photo-micrograph studies of organisms discussed. ... Many of the most important water works specify Nichols *Triangle Brand* Copper Sulphate. Triangle Brand is available in several convenient sizes for water treatment. Write *today* for details and book.
*(Director of Laboratories, Dept. of Water Supply, City of New York)
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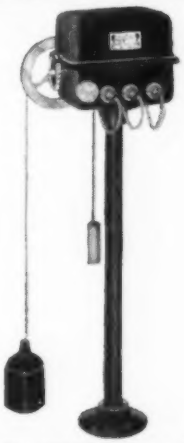

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FLOAT CONTROL for Multi-Pump Installation. Can be furnished with the Built-in ALTO-TROL. The two-pump RF-2 operates Pumps alternately, or together, as demand requires . . . RF-2 is one of a full Line of Automatic Controls developed to satisfy every requirement. They have been standard in Sewage Plants of every size for a great many years. When you write advise number of pumps and all other requirements.

WRITE For BULLETIN RF-2

Water Levels Controls Division
HEALY-RUFF COMPANY
783 Hampden Ave., St. Paul 4, Minn.

1011
THE WHEELABRATOR

The American Wheelabrator and Equipment Corp., Mishawaka, Ind., has available a catalog on its **Multi-Table Wheelabrator.** The catalog shows the design of the Wheelabrator and how it works to sand blast such items as meter castings and parts by the use of centrifugally forced shot for abrasive. The complete description and the operation of the equipment is shown.

To obtain a copy of this bulletin on the Multi-Table Wheelabrator mail a Reader Service Card containing your name and address and the above key number.

1012
GUIDE FOR MOTOR SELECTION

Allis-Chalmers Manufacturing Co., Milwaukee 1, Wis., has published a **Handy Guide for Quick Selection of Electric Motors.**

This is a 12-page bulletin provided with detailed specifications covering squirrel-cage induction motors and application data, range of sizes and speed torque curves on synchronous, wound rotor and direct current motors.

Also included is a complete line of motor controls for every requirement of motor operation. Charts list the range of each type of control in voltage and horsepower, etc.

Copies of this Handy Guide are available on request. Just enter the above key number and your name and address on a Reader Service Card and mail to this magazine.

1013
AERATION EQUIPMENT

The American Well Works Co., Aurora, Ill., has available Bull. No. 265 on **Aeration Equipment.** This bulletin shows installations of, and describes, not only mechanical aeration in the activated sludge process, but also the new jet aeration principle developed by the American Well Works Co.

A picture and diagram of the mechanical aeration unit is shown and its use described. Likewise the principle of the jet aerator is diagrammed and discussed. Advantages claimed for the jet aerator includes 20 per cent absorption of oxygen of the air and elimination of clogging of aerators.

If you desire a copy of this bulletin enter your name and the above key number on a Reader Service Card and mail to this magazine.

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Time tried & Tested for over 50 Years

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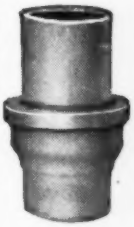

. . . Thousands of miles of pipe have been jointed with LEADITE—and Leadite not only saves *all along the line,* but it *improves* with age.

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CHLORINE GAS ACCURATELY

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Everson SterElators Operate Manually or Semi-Automatically, Also Automatically Proportion Gas Flow to Water Flow.

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A dependable self-caulking joint compound for cast iron bell and spigot water mains.

Used by hundreds of water companies—water departments and water works contractors.

NORTHROP & COMPANY, Inc.
SPRING VALLEY, NEW YORK

PAID FOR ITSELF IN 4½ HOURS!

THE "FLEXIBLE" POWER BUCKET MACHINE

is shown finishing a line cleaning job for the Borough of Wallingford, Conn. Original recommendations specified dig-up and replacement. The "Flexible" Power Bucket Machine, however, completed the entire project in 4½ hours. On estimated savings, the machine *paid for itself and then some on one short job!*

Powerful air cooled engine — exceptional job safety — perfect balance — perfected level winder — back-lash pulley — instant leg adjustment — safe speeds up to 125 ft. per minute — these are but a few of the characteristics of the work-proven "Flexible" Power Bucket Machine.

Ask the distributor nearest you for more details on this and other cost-saving, time-saving "Flexible" equipment.

FLEXIBLE SEWER-ROD EQUIPMENT CO.

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141 W. Jackson Blvd. Chicago, Ill. — 401 Broadway New York 13 — 147 Hillside Ter. Irvington, N. J. — P. O. Box 165 Atlanta — 2011 Central Ave. Memphis, Tenn.

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3786 Durango Ave. Los Angeles 34, Calif. — 909 N. Homewood Ave. Pittsburgh 8, Pa. — 4455 S.E. 24th Ave. Portland 2, Ore.

1014

WHITE WATER TREATMENT

In the July issue of the *Water Tower* published by Chicago Bridge & Iron Co., 2421 McCormick Bldg., Chicago 4, Ill., there appears a story on the use of a Marx Save-all constructed for the Robertson Paper Box Co., Inc., at Montville, Conn. The story shows pictures of the installation, describes the construction of the Save-all and explains its operation and effective results obtained therewith.

If you desire a copy of this story enter the above key number on a Reader Service Card and mail.

1015

BOOKS AND PUBLICATIONS ON WATER & SEWAGE ENGINEERING

Gilbert Associates, Consulting Engineers, of Reading, Pa., has put together a report that will be of interest to engineers, chemists, biologists and all persons connected with the fields of water supply, sewage treatment, or industrial waste disposal. This bulletin is titled **Books and Publications On Water Engineering.** It is a mimeographed bulletin which contains a list of books on water plant design and operation, books on chemistry and bacteriology, feed water, power station chemistry, power station operation, sewage and industrial waste treatment, etc.

The bulletin also contains a list of periodicals on the chemical laboratory, periodicals on power station operation, water and sewage, manufacturers' publications, U. S. government publications, etc.

Also included are addresses of engineering societies, addresses of publishers, index to authors and an index to titles.

If you desire a copy of this book enter the above key number and your name and address on a Reader Service Card.

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THE FLUSHING ACTION IS APPLIED BY COLLAPSING THE SHIELD.

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Standard machines stocked 8 inches to 96 inches—For sale, rent or contract.

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Coral Gables 34, Fla.

1016

CHEMICAL PUMPS

Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa., has just published Bull. No. 484 titled **Milton Roy Pumps.** The bulletin features a capacity-pressure chart, in simplified form, for pump selection. The bulletin also describes how the step-valve works, volumetric efficiency, and the self cleaning properties of the ball-checks.

If you are interested in a controlled volume pump send for this bulletin by entering the above key number on one of our Reader Service Cards and mailing to this magazine.

1017

AIR COMPRESSORS

The Jaeger Machine Co., Columbus 16, Ohio, has issued a catalog number JC-8 on the Jaeger new standard **"Air Plus" Compressors.** This catalog covers the compressors from 75 cfm. to 600 cfm.

It is a well known fact, as many water and sewage works superintendents, managers, and operators have attested in the survey published in *Water & Sewage Works,* that air compressors are vital to the operation of water and sewage works systems. This bulletin will be of considerable interest to water and sewage works managers for that reason. It contains information on the various sizes and models available in the new "Air Plus" compressor design of the Jaeger Co.

To obtain a copy of this bulletin enter the above key number on a Reader Service Card and mail.

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* Hydrauger

* Reg. U. S. Pat. Office

HY-13b

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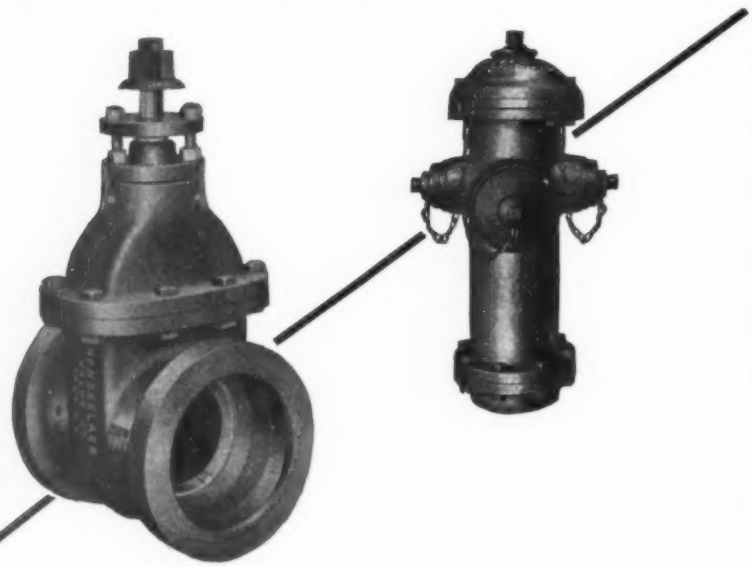

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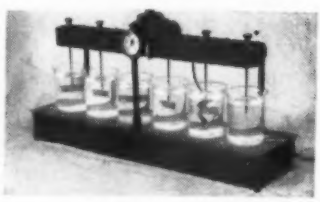

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IS the important piece of equipment in the Modern Water Works Laboratory. Now being used by leaders in water works research. Many superintendents and chemists have been able to reduce their chemical costs by the control of chemical dosages with this mixer. Write for literature.

PHIPPS & BIRD, INC. Richmond, Va.

1018

SPIRAL CONVEYORS

The Jeffrey Manufacturing Co., Columbus 16, Ohio, has issued Catalog 803 on the **Jeffrey Spiral Conveyor.**

This 48-page catalog is complete with information on the design, construction, operation, and installation of the Jeffrey Spiral Conveyor. Tables of data, formula, and discussions make the catalog useful to any designing engineer or water and sewage works operator or manager who is faced with the problem of transporting materials.

To obtain this catalog, enter the above key number on a Reader Service Card and mail.

FOR SALE

2—Infilco Rate of Flow Controllers Type CD-G Hydraulic & Automatic. From Army Surplus. Price 50% off current factory price. **Power Supply & Engineering Co., 500 Magazine St., New Orleans.**

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The City of Keene, New Hampshire (14,000) is receiving applications for the position of Superintendent of Public Works. Department includes water supply and sewage disposal.

Applications should show education and experience in detail stating minimum acceptable salary. References desired. Applications will be kept confidential on request. Address Henry F. Goodnow, City Manager.

PUBLIC UTILITY MANAGER

As Assistant Manager in operation of group of water supply properties on Long Island with gross annual revenues of about $1,000,000. Must be experienced and have full knowledge of construction, operation and maintenance of water works facilities. Must be versed in public relations work. Opportunity for man qualified to succeed to manager's job after demonstration of capacity to handle assignment. Interview arranged on basis of letter stating qualifications, educational background and salary desired. **Box 1000, Water & Sewage Works, 22 W. Maple Street, Chicago 10, Illinois.**

1019

PLUNGER SLUDGE PUMP

The Domestic Engine and Pump Co. of Shippensburg, Pa., has available Bulletin PS-41 on **Domestic Plunger Sludge Pumps.** This bulletin describes the construction of these pumps and shows pictures of various types and diagrams of the operation of both the simplex and duplex type pump. Rating tables are included in the bulletin.

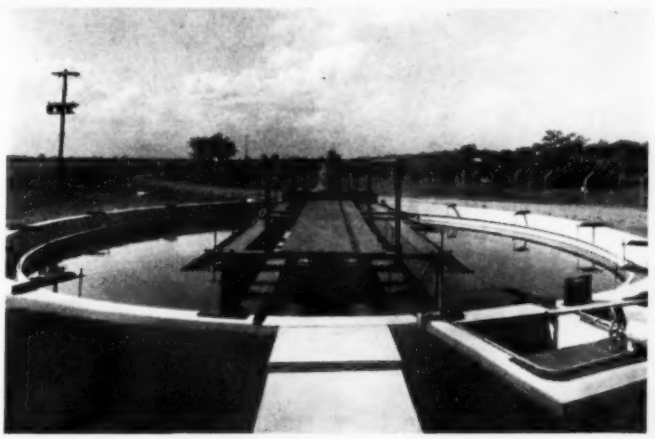
If you desire a copy of this catalog enter the above key number and your name on a Reader Service Card and mail.

1020

BACKWASH FILTER FOR SEWAGE TREATMENT

The Hardinge Co., of York, Pa., has just issued Bulletin AH382, titled the **Hardinge ABW Sand Filter for Sewage Treatment.** This four-page folder describes the application of the Hardinge Automatic Backwash Rapid Sand Filter to sewage treatment and other engineering problems. The bulletin contains performance data obtained from several filter installations now in operation.

A copy of this new bulletin may be obtained by entering your name and the above key number on a Reader Service Card.



Primary Clarifier, Hope, Arkansas

This 39 ft. Primary Spiraflo Clarifier at Hope, Arkansas, is free of objectionable floating material. A six day test made from 7 A.M. to 7 P.M. showed an average settleable solids removal of 96.9%.

The Spiraflo provides excellent removal of B.O.D., suspended solids and floating oil, grease and scum.

If you are interested in a low cost sewage sampler that may also be used to measure the volume of flow, investigate the Trebler Sampler.

Trickling filter distributors are available for conventional and high capacity filters.

LAKESIDE ENGINEERING CORPORATION
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FOR

pH Control and WATER TESTS

A study of our 28-page Bulletin No. 602, containing the complete line of Hellige apparatus for pH control and water analysis, will enable you to form an intelligent opinion as to what is best suited for extending your present equipment or for an initial installation.

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Reconditioning meters this effective Oakite way is fast, easy. Saves hours usually spent on scratch brushing. Oakite is available in unlimited quantities. FREE data gives further information. Write.

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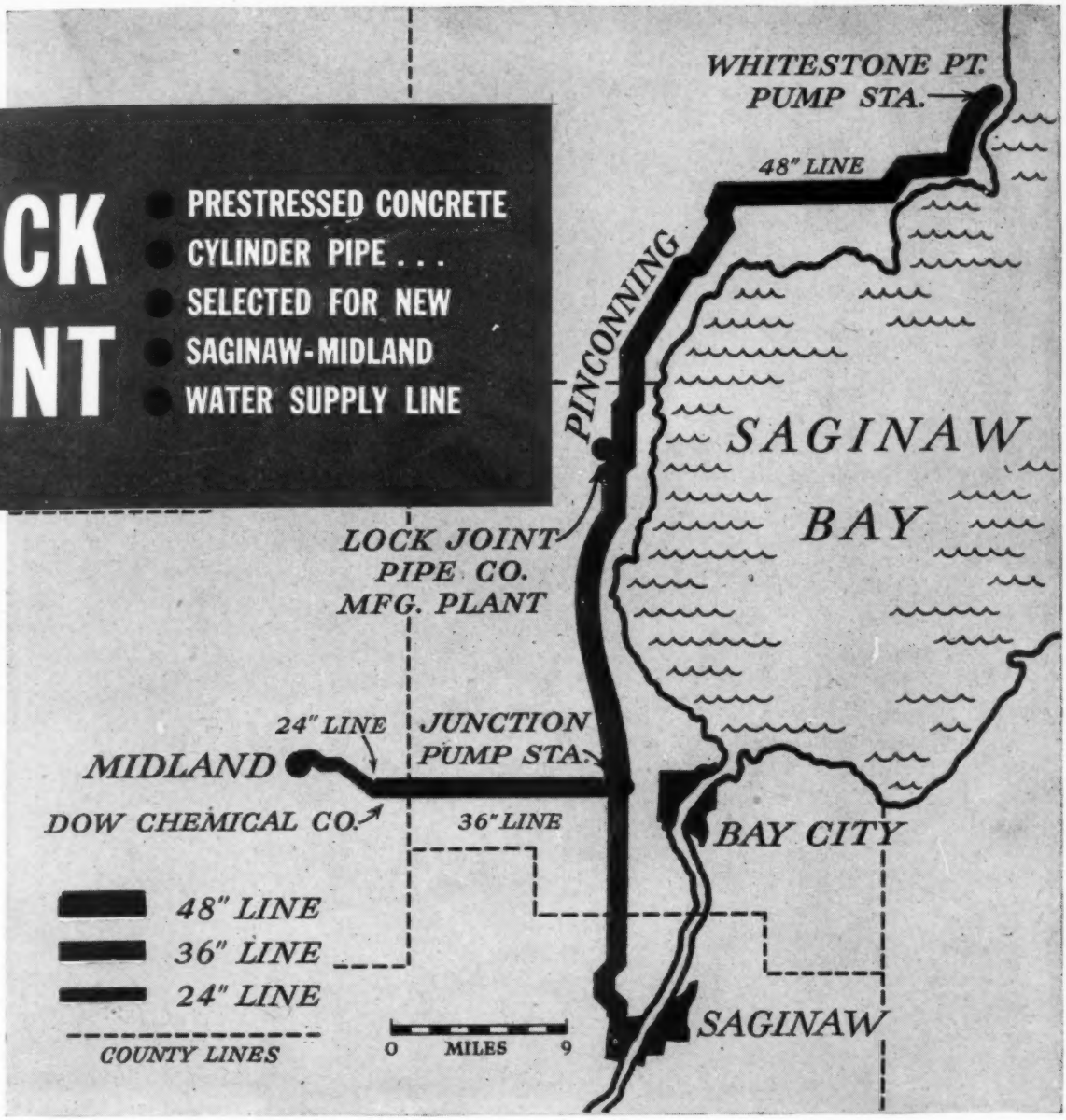

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